Chapter: 2

State(s): Oregon

Recovery Unit Name: Klamath River

Region 1
U.S. Fish and Wildlife Service
Portland, Oregon

DISCLAIMER

Recovery plans delineate reasonable actions that are believed necessary to recover and/or protect the species. Recovery plans are prepared by the U.S. Fish and Wildlife Service and, in this case, with the assistance of recovery unit teams, State and Tribal agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views or the official positions or indicate the approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. Recovery plans represent the official position of the U.S. Fish and Wildlife Service *only* after they have been signed by the Director or Regional Director as *approved*. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

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KLAMATH RIVER RECOVERY UNIT CHAPTER OF THE BULL TROUT RECOVERY PLAN

EXECUTIVE SUMMARY

CURRENT SPECIES STATUS

Klamath River bull trout were listed as a distinct population segment in 1998 (63 FR 31647) because they are physically isolated from other bull trout by the Pacific Ocean and several small mountain ranges in central Oregon. Recovery of bull trout in the Klamath River Recovery Unit, which includes three core areas and nine currently identified local populations, will require cooperation from Federal, State, and local agencies, and Tribal and private entities. Within the Klamath River Recovery Unit, abundance has been severely reduced and remaining populations are fragmented.

HABITAT REQUIREMENTS AND LIMITING FACTORS

Watershed disruption has played a major role in the decline of bull trout in the Klamath River basin. The effects of historical land use on fish habitat in the larger tributaries and mainstem rivers of the Klamath River basin have been profound. Channelization, water withdrawals, removal of streamside vegetation, and other disturbances have altered the aquatic environment by elevating water temperatures, reducing water quantity and quality, and increasing sedimentation. Changes in or disruptions to watershed processes that influence characteristics of stream channels have also influenced the dynamics and persistence of bull trout populations. Klamath River basin bull trout are threatened by habitat degradation, past and present land use management practices, agricultural water diversions, and competition or hybridization from nonnative brown and brook trout. As a result of past land and resource management practices, bull trout populations in the Klamath River Recovery Unit are small, disjunct, and face a high risk of extirpation.

RECOVERY GOAL AND OBJECTIVES

The goal of the bull trout recovery plan is to **ensure the long-term persistence of self-sustaining, complex interacting groups of bull trout distributed across the species range, so that the species can be delisted.** In order to recover bull trout in the Klamath River, the following objectives need to be met:

- Maintain current distribution of bull trout and restore distribution in previously occupied areas within the Klamath River Recovery Unit, as noted in Appendix A.

- Maintain stable or increasing trends in abundance of bull trout within the Klamath River. This objective includes the expression of all life history strategies including resident, fluvial, and adfluvial forms in the Upper Klamath Lake core area and resident and fluvial forms in the Sycan River and Upper Sprague River core areas.

- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies. In core areas and migration corridors, stable or upward trends in habitat quality are achieved through landscape-level adjustments in land management strategies designed to maintain and/or enhance structural and functional attributes of upslope, riparian, and fluvial systems.

- Conserve genetic diversity and provide opportunity for interchange of genetic material among appropriate core populations.

RECOVERY CRITERIA

Recovery criteria for the Klamath River Recovery Unit reflect the stated objectives and consideration of population and habitat characteristics within the recovery unit. Using four population and habitat elements, the Klamath River Recovery Unit Team categorized bull trout into three groups of relative risk:

diminished, intermediate, and increased. Team members evaluated bull trout under current and potential recovered conditions based on the number of local populations, adult abundance, population trends and variability, and connectivity of the system. These elements were derived from the best scientific information available concerning bull trout population and habitat requirements. Evaluation of these elements under a recovered condition assumed that actions identified within this chapter had been implemented.

1. **Distribution criteria will be met when current distribution of bull trout in the 12 local populations is maintained and distribution is expanded by establishing bull trout in areas identified as suitable for potential local populations.** The number of existing local populations by core area are as follows: Upper Klamath Lake, 3; Sycan River, 2; and Upper Sprague River, 7. Achieving criterion 1 entails maintaining existing local populations and establishing additional potential local populations in all core areas in the recovery unit to maintain current and recovered distribution. To achieve criterion 1 and to ensure a core area population of no fewer than 100 adult bull trout, establishing at least 5 to 7 local populations in the Klamath Lake core area among 15 potential local populations (2 to 5 new local populations), at least 5 to 7 local populations in the Sycan River core area from among 15 potential local populations (3 to 5 new local populations), and at least 10 to 12 local populations in the Upper Sprague River core area from among 25 potential local populations (3 to 5 new local populations) is necessary.

2. **Abundance criteria will be met when the estimated number of adult bull trout is at least 8,250 individuals distributed among the Upper Klamath Lake, Sycan River, and Upper Sprague River core areas, based on 10 years of monitoring data.**

3. **Trend criteria will be met when adult bull trout exhibit stable or increasing trends in abundance in the Upper Klamath Lake, Sycan River, and Upper Sprague River core areas, based on 2 generations (10 years) of monitoring data.**

4. **Connectivity criteria will be met when specific barriers to bull trout migration in the Klamath River Recovery Unit have been addressed.** In the Klamath River Recovery Unit, this objective means addressing passage: 1) existing culverts that impede passage should be replaced, including those on Threemile Creek at U.S. Forest Service Road 110 crossing, Brownsworth Creek at U.S. Forest Service Road 34 crossing, and Brownsworth Creek both 0.75 mile and 1.25 miles above U.S. Forest Service Road 34; the culvert 0.25 mile below U.S. Forest Service Road 34 (to prevent repeated washout); the large-diameter culvert at the Boulder Creek road crossing; culverts in the upper Sycan River watershed that are identified in the Fremont National Forest inventory; and several in the North Fork Sprague River drainage, namely, on North Fork Sprague River (2), Boulder Creek (1), Dead Cow Creek (1), and Sheepy Creek (1); 2) fish passage structures should be installed at water diversions on bull trout streams, and barriers should be removed, including on Cherry, Sevenmile, Sun, and Threemile Creeks; 3) fish screens should be installed to prevent fish from entering diversion canals or pipes, including on Long, Deming, Threemile, Sun, Sevenmile, and Cherry Creeks; 4) manmade barriers and entrainment should be evaluated and remedied to promote migratory bull trout; priority watersheds include Threemile, Long, Deming, Sevenmile, Cherry, Sun, and Long Creeks.

The Klamath River Recovery Unit team expects that the recovery process will be dynamic and will be refined as more information becomes available. Future adaptive management will play a major role in recovery implementation and refinement of recovery criteria. The recovery unit criteria listed above will be used to determine when the Klamath River Recovery Unit is fully contributing to recovery of the Klamath River population segment.

ACTIONS NEEDED

Recovery for bull trout will entail reducing threats to the long-term persistence of populations and their habitats, ensuring the security of multiple interacting groups of bull trout, and providing habitat and access to conditions that allow for the expression of various life history forms. The seven categories are listed in Chapter 1; tasks specific to this recovery unit are provided in this chapter.

ESTIMATED COST OF RECOVERY

Total cost of bull trout recovery in the Klamath River Recovery Unit is estimated at about $26 million spread over a 25-year recovery period. Successful recovery of bull trout in the recovery unit is contingent on removing threats from nonnative species, eliminating barriers to fish movement, and improving habitat conditions within the Klamath River basin. Total cost includes estimates of expenditures by local, Tribal, State, and Federal governments and by private business and individuals. Cost estimates are not provided for tasks which are normal agency responsibilities under existing authorities. The estimated costs are attributed to bull trout conservation, but other aquatic species will also benefit.

ESTIMATED DATE OF RECOVERY

Time required to achieve recovery depends on bull trout status, factors affecting bull trout, implementation and effectiveness of recovery tasks, and responses to recovery tasks. A tremendous amount of work will be required to restore impaired habitat, reconnect habitat, and eliminate threats from nonnative species. Three to five bull trout generations (15 to 25 years), or possibly longer, may be necessary before identified threats to the species can be significantly reduced and bull trout can be considered eligible for delisting.

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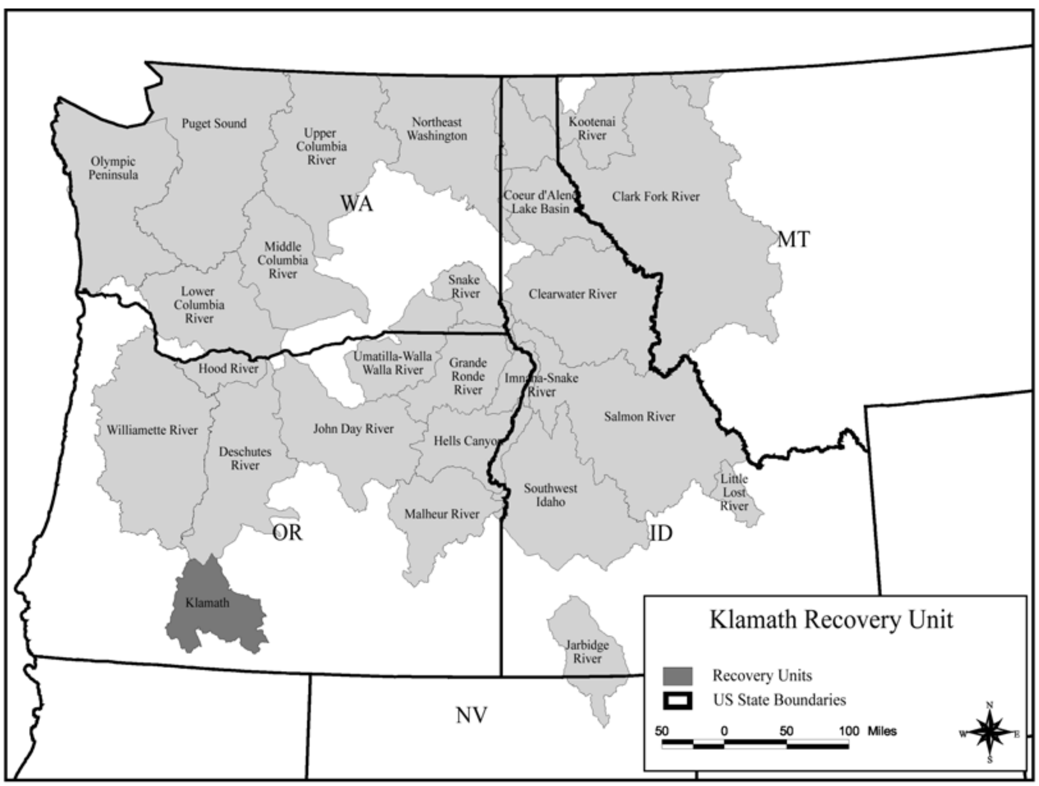
INTRODUCTION

Recovery Unit Designation

The Klamath River Recovery Unit (Figure 1) includes three distinct watersheds: the Upper Klamath Lake watershed, the Sycan River watershed, and the upper Sprague River watershed. These watersheds were included in a single recovery unit because bull trout probably functioned as a single unit historically.

Figure 1. Bull trout recovery unit in the United States. The Klamath River Recovery Unit is highlighted.



Status of Bull Trout at Time of Listing

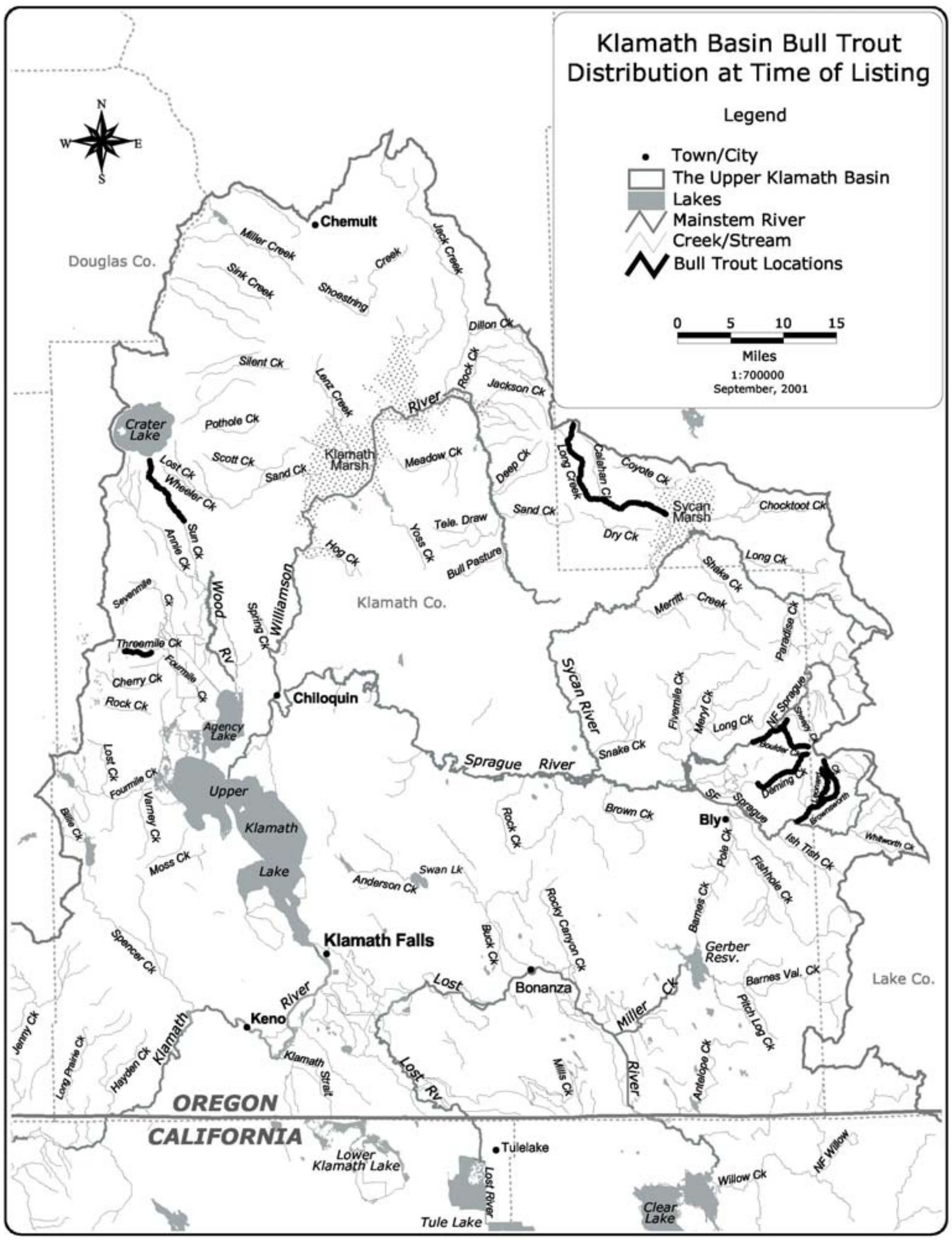
In the final listing rule (63 FR 31647), seven subpopulations of bull trout were identified within three watersheds in the Klamath River basin: (1) Upper Klamath Lake—Threemile and Sun Creeks; (2) Sycan River—Long Creek; and (3) upper Sprague River—Deming, Leonard, Brownsworth, and Boulder-Dixon Creeks (Figure 2). The Oregon Chapter of the American Fisheries Society (OCAFS) reported that almost 40 percent of the known Klamath River basin populations have been extirpated in recent years (OCAFS 1993).

Geographic Description

The Klamath River and its tributaries flow through a total of seven counties, two in southern Oregon (Klamath and Josephine Counties) and five in northwestern California (Modoc, Siskiyou, Trinity, Humboldt, and Del Norte Counties), before reaching the Pacific Ocean. The Klamath River basin consists of approximately 10 million acres and has its headwaters in south-central Oregon (ODFW 1997). Elevations vary from 840 meters (2,755 feet) in the Klamath River canyon at the state line to 2,894 meters (9,495 feet) on Mt. McLoughlin in the Cascades and 2,549 meters (8,364 feet) on Gearhart Mountain at the eastern edge of the basin. Most of the drainage tributaries funnel through Upper Klamath Lake, elevation 1,261 meters (4,140 feet), before spilling into Link River and Lake Ewauna at the head of the Klamath River (ODFW 1997).

The Upper Klamath Lake core area (Figure 3) is comprised of the lake and its immediate major and minor tributaries. The lake is the collection point for most of drainage tributaries, with a surface area of 37,260 hectares (92,000 acres). It is classified as hypereutrophic (or highly productive) (ODFW 1997). This core area incorporates the Upper Klamath Lake drainage, including waters draining from Crater Lake National Park south of Scott Peak and from the area west of and including the Williamson River below Klamath Marsh. Also included is the west

Figure 2. Distribution of bull trout in the Klamath River at time of listing.

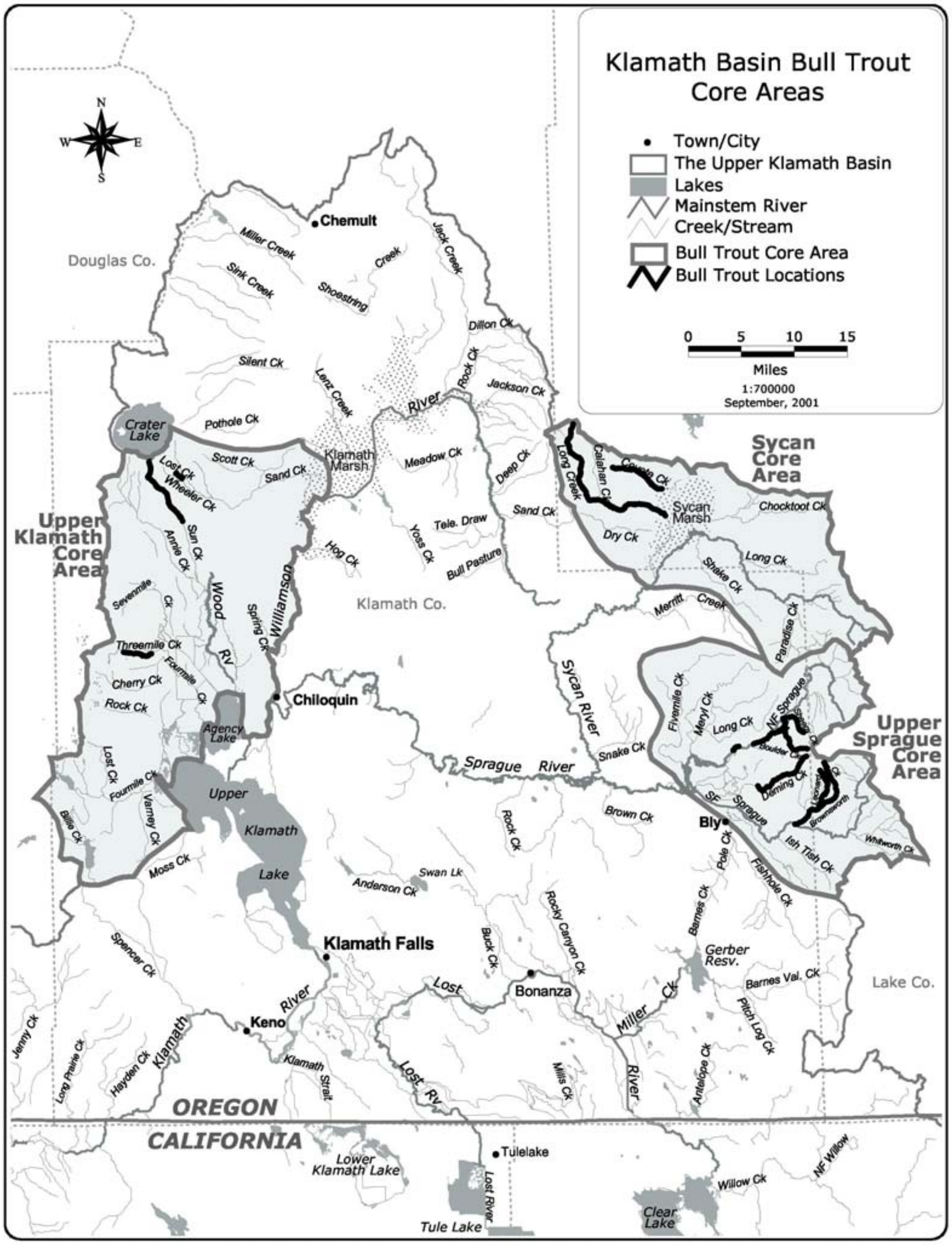


side of the Winema National Forest from Crater Lake National Park south into the Spencer Creek and Varney Creek drainages on the west side of Klamath Lake. This core area includes three existing local bull trout populations: Threemile Creek, Sun Creek, and Lost Creek. Sun Creek, in Crater Lake National Park, currently supports the largest local population in the Upper Klamath Lake core area. Major tributaries are the Williamson and Wood Rivers. Numerous small streams that are spring fed and surface water fed originate along the rim of the basin.

The Sycan River core area is comprised of the Sycan Marsh and its tributaries and the Sycan River and its tributaries. The Sycan River originates from springs near 2,133 meters (7,000 feet) on the eastern edge of the Klamath River basin. The river flows through high-elevation meadows and forest lands for 74 kilometers (46 miles). It flows through the Sycan Marsh for 15 kilometers (9.3 miles) from river kilometer 74 (river mile 45) to river kilometer 57 (river mile 36). Long and Coyote Creeks are tributaries on the west side of the marsh (ODFW 1997). After exiting the Sycan Marsh, the river flows through a variety of landscapes, including forested rim-rock canyons and open pasture land until it joins the Sprague River. This core area is composed of the waters that drain into the Sycan Marsh, including Long, Calahan, and Coyote Creeks on the west side of the marsh. On the east side of the marsh are the upper Sycan River, Chocktoot Creek, Shake Creek, and their tributaries. The largest local population in the Sycan River core area is found in Long Creek. Bull trout have been found distributed throughout the length of Long Creek and into sections of the Sycan Marsh. The Coyote Creek local population appears to be recently reestablished. Prior to presence/absence surveys in 1998, bull trout in Coyote Creek where thought to be extirpated.

The Upper Sprague River core area is comprised of drainages of the North and South Forks of the Sprague River. It begins 135 kilometers (84 miles) upstream of the mainstem Sprague River's confluence with the Williamson River. The origin of the North and South Forks are from small, mainly spring fed,

Figure 3. Map of Klamath River Recovery Unit core areas.



streams, near 2,926 meters (6,900 feet) elevation on the north and southeast sides of Gearhart Mountain. The upper few miles of each meander through high-elevation meadow and forest lands before being confined by narrow forested canyons (ODFW 1997). The lower stretches of the North and South Forks meander through the broad, low-gradient Sprague River valley. The Upper Sprague River core area is comprised of the drainages of the North and South Forks of the Sprague River upstream of their confluence, including Deming, Boulder/Dixon, Sheepy, Brownsworth, and Leonard Creeks. Deming Creek currently supports the largest local population of bull trout in the Upper Sprague River core area. Presence/absence surveys in 1998 discovered bull trout in the North Fork Sprague River below the confluence with Boulder Creek. Surveys also discovered bull trout in Sheepy Creek, where bull trout had previously been thought to be locally extirpated.

The climate of the Klamath River basin, the product of wind from the west and the Cascade rain shadow, varies from sub-humid to semi-arid depending on elevation (Weyerhaeuser 1995). Average annual precipitation ranges from 45 to 102 centimeters (18 to 40 inches), falling primarily as winter snow, with little rainfall during the growing season. While precipitation is generally greater in the higher elevations, much of the surface water for perennial streams is supplied by springs below 2,040 meters (6,700 feet). Runoff primarily consists of a base-level perennial discharge from springs and seasonal (mid spring) discharge from snowmelt. Rare rain-on-snow events may also occur in early fall or during spring snowmelt (Weyerhaeuser 1995). Growing seasons are typically dry with localized thunderstorms.

Temperatures vary widely both diurnally and seasonally. High temperatures at lower elevations may exceed 32 degrees Celsius (89 degrees Fahrenheit), while the low temperatures in upper elevations may drop below –30 degrees Celsius (–22 degrees Fahrenheit). Mean annual temperatures range from 8 degrees Celsius (46 degrees Fahrenheit) at lower elevations to 7 degrees Celsius (44 degrees Fahrenheit) at higher elevations (Weyerhaeuser 1994).

The upper Klamath River lies within the geologic provinces of the Cascade Range and the Modoc Plateau (USFWS 1997). The Cascade Range extends northward through Oregon and Washington into British Columbia, and the Modoc Plateau extends into Oregon and southeastward into Nevada. The outstanding characteristics of the region are: (1) the dominance of volcanism and (2) the presence of broad areas of nearly flat basalt plains (USFWS 1997).

The Klamath River basin region of the Modoc Plateau supports some large and geologically old wetlands. The river systems of this area were once connected to both the Snake River drainage to the north and east and the Sacramento and San Joaquin drainage to the south. Bull trout streams in the Klamath River basin are located in three subbasins: (1) the Upper Klamath Lake subbasin, (2) the Sycan River subbasin, and (3) the upper Sprague River subbasin.

The Upper Klamath Lake subbasin is located on the eastern flank of the Cascade Mountains. These mountains are formed from basaltic andesites and pyroclastics and from volcanically derived sedimentary rocks that were formed by the activity of shield volcanoes during the Eocene period. After the volcanic activity, several glacial events carved and reshaped the topography. The glaciers were followed by a period of faulting. The eruption of Mount Mazama about 6,500 to 7,000 years ago blanketed the Cascade Range with pumice and ash.

The Sycan River subbasin originated during regional faulting events in the Pliocene Epoch. Volcanic layers of andesite and pumice formed the high lava plains in which these streams occur. The area has a bench-like appearance due to a set of resistant rock strata. These strata control channel location within the basin.

In the upper Sprague River subbasin, the dominant geologic feature is Gearhart Mountain, a dome-shaped shield volcano. The primary substrate is basaltic lava with localized rhyolitic lava also occurring. During past volcanic events, extensive lava flows formed the plateaus that basin streams cross in lower elevations.

Soils are typical of semi-arid eastern Oregon areas and are moderate to highly erodible (Weyerhaeuser 1994, 1995). Three soil groups with associated vegetation influence the hydrology and channel characteristics: lower-elevation residual soils, upper-elevation pumice soils, and meadow soils.

Lower-elevation residual soils are derived from interbedded basalt, andesite, and tuff. Native vegetation includes ponderosa pine (*Pinus ponderosa*) communities and juniper (*Juniperus* species) communities (Franklin and Dyrness 1984).

Upper-elevation pumice soils are formed of Mazama ash and pumice overlying earlier eruptive andesitic and basaltic flows. They are often stony, containing boulders weathered from pillow lava. Native vegetation includes white fir (*Abies concolor*), pinemat (*Ceanothus diversifolius*), waxcurrant (*Ribes cereum*), lupine (*Lupinus* species), and Ross's sedge (*Carex rossii*) (Franklin and Dyrness 1984; Weyerhaeuser 1994, 1995).

Meadow soils have high clay content, formed from the weathering of former lacustrine deposits. Occurring over a wide range of elevations in low-lying areas where deep deposits have accumulated, these soils are dark, poorly drained, and remain saturated with water for much of the year. Plants associated with them are Kentucky bluegrass (*Poa pratensis* ssp. *agassizensis*), meadow foxtail (*Alopecurus pratensis*), California false hellebore (*Veratrum californicum*), rushes (*Scirpus* species) and sedges (*Carex* species). Springs are often associated with meadows (Franklin and Dyrness 1984; Weyerhaeuser 1994, 1995).

Fisheries Resources

Current fish communities are very different from those of the recent past. The Klamath River system once held large populations of shortnose suckers (*Chasmistes brevirostris*), Lost River suckers (*Deltistes luxatus*), and Klamath largescale suckers (*Catostomus snyderi*) (Buettner and Scoppettone 1990). The shortnose and the Lost River suckers are currently federally listed as endangered species (53 FR 27130). The drainage also supported chinook salmon

(*Oncorhynchus tswawytscha*) and steelhead (*O. mykiss*) (Fortune *et al*. 1966; Kostow 1995).

The Klamath River basin no longer supports the historic abundance of native fish species. Large populations of suckers no longer use the river. Runs of anadromous salmonids (chinook and steelhead) no longer exist because the Copco Dam, built in 1917, has blocked migration (Fortune *et al*. 1966). Planting of nonnative brook (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) has also altered the river's fish community (Weyerhaeuser 1995). Klamath Lake redband trout, the resident form of *O. mykiss*, persist in the Klamath River basin, and exhibit resident, fluvial, and adfluvial life histories (Kostow 1995). Although described from trout inhabiting Klamath Lake, the systematic classification of Klamath Lake redband trout from the lake and higher-elevation waters is unclear (Behnke 1992).

DISTRIBUTION AND ABUNDANCE

Current Distribution and Abundance

Since bull trout became listed as threatened in the Klamath River basin in 1997, the extent of known bull trout-occupied habitat has been expanded slightly, from seven to nine existing populations (Table 1). A local population of bull trout has been established in Lost Creek in Crater Lake National Park (Klamath Lake core area), and bull trout have been rediscovered in Coyote Creek (Sycan River core area), a local population formerly thought to have been extirpated. Additionally, several extensions of existing populations have also been discovered.

Upper Klamath Lake Core Area

As recently as the 1970s, bull trout were documented in Cherry and Sevenmile Creeks (Ratliff and Howell 1992; Light *et al*. 1996), although bull trout in both streams are thought to be extirpated. Surveys in 1990, 1991, and 1997 failed to detect any bull trout in Cherry Creek (OCAFS 1993; Buchanan *et al*. 1997; B. Quick, Oregon Department of Fish and Wildlife, pers. comm., 1999), and bull trout are also believed to be extirpated from Sevenmile Creek (Ratliff and Howell 1992; Buchanan *et al*. 1997). Bull trout have not been documented from the Wood River since 1938 (Dambacher *et al*. 1992).

In 1996, the Threemile Creek local population was estimated to be approximately 50 fish in a 1.4-kilometer (0.84-mile) reach (Buchanan *et al*. 1997) (Table 2), entirely within the upper drainage within Winema National Forest lands. Brook trout co-occurred with bull trout for 0.3 kilometer (0.18 mile) of this 1.4-kilometer (0.84-mile) reach (Buchanan *et al*. 1997).

In 2000, the results of an intensive snorkel survey of Threemile Creek indicated a population of at least 91 bull trout (KBBTWG, *in litt.,* 2000) in a 3.9-kilometer (2.4-mile) stretch. Recently, the Oregon Department of Fish and

Table 1. Summer distribution of bull trout and nonnative brown or brook trout in the Klamath River basin (adapted from Buchanan *et al*.1997).

Stream	Kilometers of bull trout only	Kilometers of bull and brook trout	Kilometers of bull and brown trout	Total kilometer s
Boulder/Dixon Creeks	1.6	0.0	7.4	9.0
Brownsworth Creek	0.0	0.0	15.0 [a]	15.0
Deming Creek	6.4 [b]	0.0	0.0	6.4
Leonard Creek	2.2	0.0	0.5 [c]	2.7
Long Creek	0.0 [d]	23.2 [e]	0.0	23.2
Sun Creek	14.5 [f]	0.0	0.0	14.5
Threemile Creek	1.1	0.3	0.0	1.4
Totals	25.8	23.5	22.9	72.2

[a] In 1994, 2.3 kilometers of bull trout plus brown trout were estimated in Brownsworth Creek; however, this distribution was reduced to 0.3 kilometers in summer 1995 because only brown trout were found in the lower 2.0 kilometers. In 2000, bull trout plus brown trout were found down to the confluence with the South Fork Sprague River.

[b] In Deming Creek, 6.4 kilometers of bull trout are sympatric with native redband trout.

[c] In 1994, an estimated 1.9 kilometers of bull trout plus brown trout were in Leonard Creek; however, this distribution was reduced to 0.5 kilometer in summer 1995 because only brown trout were found in the lower 1.4 kilometers.

[d] In 1991, 2.8 kilometers of pure bull trout were in Long Creek. An invasion of brook trout recorded in 1994 reduced this distance to only 1.3 kilometers (Light *et al*. 1996). No reaches of only bull trout were recorded in 2000 (KBBTWG, *in litt*., 2000).

[e] In 1999 and 2000, surveys extended bull trout usage to the length of Long Creek. Radio telemetry indicates that bull trout also use portions of the Sycan Marsh. These fish may be either fluvial or adfluvial.

[f] Prior to 2000, 6.2 kilometers of bull trout plus brook trout were within the boundaries of Crater Lake National Park. In August 2000, brook trout were removed by application of antimycin.

Wildlife during a survey of private lands below the Westside Road did not encounter any bull trout and only a low incidence of redband trout (B. Quick, pers. comm., 2000).

The Sun Creek local population was estimated to be 133 adult bull trout (105 spawners) in 1989 (OCAFS 1993) in a 6.2-kilometer (3.9-mile) reach of Sun Creek, which is entirely within Crater Lake National Park (Buktenica 1997). During 1992 to 1994, annual estimates of bull trout abundance ranged from 120 to 260 fish (Buktenica 1997). In 2000, bull trout abundance was 635 fish for the

Table 2. Estimated abundance of bull trout, spawners, female spawners, and effective population size in six Klamath River basin streams (adapted from Buchanan *et al*. 1997).

Stream	Abundance [a]	Percent greater than 140 millimeters [b]	Spawner abundance (N) [c]	Percent females [d]	Female spawner abundance	Effective population (N_e) [e]
Boulder/Dixon	219	64	140	30	42	14-46
Brownsworth	964	46	443	30	133	44-146
Deming	1293	47	608	46	280	64-201
Leonard	834	25	208	33	69	21-69
Long	842	43	362	50	181	36-119
Sun	635	_ [f]	_ [f]	50	_ [f]	_ [f]
Threemile	91	61	45	50	22	5-15

[a] From Ziller (1992), Dambacher *et al*. (1992), Buchanan *et al*. (1997). Threemile Creek abundance is based on 3-pass snorkel surveys in 2000; Sun Creek abundance is based on 2000 nonnative removal project.

[b] Length of spawners assumed to be 140 millimeters or greater; may overestimate spawners because length of spawners in Sun Creek in 1947 was 160 to 184 millimeters. Percentage of length samples greater than or equal to 140 millimeters was estimated from Ziller (1992) and ODFW (1991, 1992) for Long Creek.

[c] Because length frequency data were not available, bull trout greater than 100 millimeters were assumed to be spawners, although this assumption probably overestimates spawners.

[d] Based on sex ratios in Rode 1990. An average sex ratio was used for Boulder and Brownsworth Creeks, and an estimated sex ratio of 1:1 was used for Sun and Long Creeks. Threemile Creek number of spawners is based on length frequencies for data from 1998 (50), 1999 (43), and 2000 (45).

[e] N_e was calculated by assuming that N_e/N ranges from 10 percent to 33 percent and that spawner abundance is an approximation of the adult population (Buchanan *et al.* 1997).

[f] Not available.

14.5 kilometers (8.7 miles) of stream within the National Park boundaries (M. Buktenica, Crater Lake National Park, pers. comm., 2000). In 1999, 119 bull trout were transplanted into Lost Creek in Crater Lake National Park to insure against loss of the original genetic stock during efforts to remove nonnative salmonids from Sun Creek.

Sycan River Core Area

Long Creek, a tributary of the Sycan River, has the only sizable population of bull trout in the Sycan River drainage. Buchanan *et al*. (1997) considered bull trout in the upper Sycan River to be "probably extinct". Several reports mention bull trout captured in the upper Sycan River as late as 1994 (Buchanan *et al*. 1997).

Bull trout are thought to be locally extirpated in Calahan Creek, Sycan River, and the South Fork Sycan River (Ratliff and Howell 1992; Ziller 1992; Light *et al*. 1996; Buchanan *et al*. 1997). The most recent capture of a bull trout hybrid in Calahan Creek occurred in 1993 (Light *et al*. 1996).

In 1998, presence/absence surveys discovered bull trout in Coyote Creek, were the fish was previously thought to be locally extirpated. Two bull trout and two bull trout/brook trout hybrids were observed (B. Quick, pers. comm., 1999). Because of the close proximity of Coyote Creek to Long Creek and because of the interconnectivity of canals and the Sycan Marsh, these fish probably originated from the Long Creek population.

In 1991, the Long Creek local population was estimated at 842 fish, with a spawning-size abundance of 362 adults (OCAFS 1993). In 1994, biologists estimated 855 bull trout in Long Creek. In 1995, the estimated bull trout population declined approximately 50 percent (approximately 400 fish) (Buchanan *et al*. 1997). Sampling in the 1990's indicated increasing numbers and multiple age classes of brook trout co-occurring with bull trout (Light *et al*. 1996). Population surveys in 2000 (KBBTWG, *in litt.,* 2000) led to estimates of 491 bull trout in the upper 3.4 kilometers (2.1 miles) of Long Creek. Population estimates are not available for the reaches below river kilometer 21.2 (river mile 13.2).

Prior to 1999, bull trout inhabited only the upper 3.4 kilometers (2.1 miles) of Long Creek. Buchanan *et al*. (1997) reported that Long Creek bull trout distribution had been reduced to the upper 1.3 kilometers (0.8 mile) of the drainage, a reduction in range of 1.5 kilometers (0.9 mile) since 1994. Presence/absence surveys in 1999 and 2000 indicated that bull trout are distributed in Long Creek upstream of the Sycan Marsh upstream for 23.2 kilometers (13.9 miles) (KBBTWG, *in litt.,* 2000). Within the Long Creek watershed, fish occupying the upper 2.8 kilometers (1.7 miles) are within the Fremont National Forest, while those within the lower reaches are on private land (U.S. Timberlands, Inc.) (Light *et al*. 1996).

Until 1998, only resident bull trout were thought to occur in Long Creek, although the capture of a 510-millimeter (20-inch) bull trout (Light *et al*. 1996) indicated the possible persistence of fluvial or adfluvial life history forms. In 1998, the observation of large fish up to 425 millimeters (16.7 inches) during presence/absence surveys and brook trout removal efforts further support the possible persistence of fluvial or adfluvial forms (J. Zauner, Oregon Department of Fish and Wildlife, pers. comm., 1998). In 1998, presence/absence surveys also found bull trout in downstream reaches of Long Creek that were previously thought to be uninhabited. Because downstream reaches of Long Creek and portions of the Sycan Marsh have not been surveyed or have been inadequately surveyed, bull trout distribution within this area may be more extensive than previously suspected. For example, bull trout were last documented in Coyote Creek in 1987 (Ziller 1992) and until recently were thought to be locally extirpated in this stream. During presence/absence surveys in 1998, however, bull trout were rediscovered in this stream (J. Zauner, pers. comm., 1998). In 1999 and 2000, radio telemetry studies indicated that larger bull trout use lower Long Creek and parts of the Sycan Marsh during portions of the year (B. Quick, pers. comm., 2000), suggesting possible persistence of migratory forms in the Sycan Marsh.

Upper Sprague River Core Area

At the time of listing, only five streams within the Sprague River (Boulder, Dixon, Brownsworth, Deming, and Leonard Creeks) were occupied by bull trout.

During presence/absence surveys in 1998, three bull trout were observed in Sheepy Creek, an area where the fish were previously thought to be locally extirpated (B. Quick, pers. comm., 1999). All of these streams originate in the Gearhart Mountain Wilderness Area within the Fremont National Forest.

Bull trout summer distribution in Boulder and Dixon Creeks is 9.0 kilometers (5.6 miles) within the upper portions of these streams (total combined stream length approximately 11 kilometers [6.8 miles]). Bull trout co-exist with brown trout for 0.4 kilometers (.25 mile) of this 9.0-kilometer (5.6-mile) reach (Buchanan *et al*. 1997). Because of the proximity of Boulder and Dixon Creeks, the bull trout in these two streams are considered a single population. Previous population estimates (Table 2) placed bull trout abundance in Boulder and Dixon Creeks at 219 individuals. Presence/absence surveys in 1998 failed to detect any bull trout in Boulder Creek.

Because bull trout can range downstream in Boulder and Dixon Creeks to the confluence with the North Fork Sprague River, this area of the North Fork Sprague River may be occupied by bull trout during part of the year (Light *et al*. 1996). Observations of large (greater than 400 millimeter [15.7 inches]) bull trout during presence/absence surveys in 1997 (J. Zauner, pers. comm., 1997) and an angler report (R. Smith, Oregon Department of Fish and Wildlife, pers. comm., 2000) of a bull trout greater than 355 millimeters (14 inches) in 2000 indicate that fluvial fish may still persist in the North Fork Sprague River. Unlike for the Upper Klamath Lake and Sycan River core areas, no recent extirpations of local bull trout populations have been reported in the Upper Sprague River core area.

The largest population of bull trout in the Klamath River basin, approximately 1,200 fish, inhabit Deming Creek. Summer distribution in Deming Creek is 6.4 kilometers (3.8 miles) within this 17.3-kilometer (10.7-mile) stream (Buchanan *et al*. 1997). Deming Creek bull trout naturally occur with resident redband trout (Buchanan *et al*. 1997). During the summer, bull trout distribution does not extend below a water diversion structure at river kilometer 15.6 (river mile 9.4) where nearly all water is diverted. Deming Creek flows become subsurface flows approximately 0.6 kilometer (1.0 mile) below the diversion.

The Leonard Creek local population (about 830 bull trout) (Table 2) is distributed within the upper 2.7 kilometers (1.7 mile) of this 5.2-kilometer (3.2-mile) stream. Based on 1995 data, Buchanan *et al.* (1997) reported that between 1994 and 1995, bull trout distribution in Leonard Creek was reduced by 1.4 kilometers (0.9 mile).

Buchanan *et al.* (1997) reported that bull trout in Brownsworth Creek are distributed within the upper 3.1 kilometers (1.9 miles) of the 15-kilometer (9.3-mile) stream. In 1999, presence/absence surveys indicated that bull trout in Brownsworth Creek were only found for 8.3 kilometers (5.2 miles) upstream of the confluence with Leonard Creek (B. Quick, pers. comm., 1999). Population surveys in 2000, however, indicated that bull trout were distributed throughout the 15-kilometer (9.3-mile) stream, from the confluence with the South Fork Sprague River upstream to the headwaters (KBBTWG, *in litt.,* 2000).

In summary, the current abundance, distribution, and range of bull trout in the upper Klamath River basin are greatly reduced from historical levels. In the Klamath River basin, nine local populations of bull trout persist in only 82.2 kilometers (51.1 miles) of waters in three core areas. In the Upper Klamath Lake core area, bull trout are limited to 25.9 kilometers (16.1 miles) in Threemile, Sun, and Lost Creeks. In the Sycan River core area, bull trout inhabit 23.2 kilometers (14.4 miles) in Long Creek and appear to persist in part of the Sycan Marsh. In the Upper Sprague River core area, bull trout are limited to 33.1 kilometers (20.6 miles) in Deming, Leonard, Boulder, Dixon, Brownsworth, and Sheepy Creeks and in the North Fork Sprague River. Since the 1970's, bull trout have been extirpated from Cherry and Sevenmile Creeks and are thought to be extirpated from Calahan Creek, the lower Sycan River, and the South Fork Sycan River. Klamath Basin bull trout are threatened because local populations: 1) consist primarily of resident forms, 2) currently survive in fragmented and degraded habitats, 3) are at low numbers and have low reproductive potential, 4) are subject to interspecific competition and predation from brook and brown trout, and 5) hybridize with brook trout (Light *et al*. 1996).

REASONS FOR BULL TROUT DECLINE

Watershed disruption has played a major role in the decline of bull trout in the Klamath River basin. The effects of historical land use on fish habitat in the larger tributaries and mainstem rivers of the Klamath River basin have been profound (Buchanan *et al.* 1997). Channelization, water withdrawals, removal of streamside vegetation, and other disturbances have altered the aquatic environment by elevating water temperatures, reducing water quantity and quality, and increasing sedimentation (Light *et al*. 1996). Changes in or disruptions to watershed processes that influence characteristics of stream channels have also influenced the dynamics and persistence of bull trout populations. Klamath River basin bull trout are threatened by habitat degradation, past and present land use management practices, agricultural water diversions, and competition or hybridization from nonnative brown and brook trout (USFWS 1997; 63 FR 31647).

As a result of past land and resource management practices, bull trout populations in the Klamath River Recovery Unit are small and disjunct and face a high risk of extirpation (Dambacher *et al.* 1992; OCAFS 1993; Light *et al.* 1996; Buchanan *et al.* 1997). Based on the judgment of the recovery unit team, any land- or resource-related action in bull trout watersheds has the potential to significantly impact the species and its habitat. Additionally, land- and resource-related actions in historic but currently unoccupied habitat and in habitat that has the potential to support bull trout must also be considered to fully recover the species to a level at which it can be delisted.

Water Quality

Every bull trout stream in the Klamath River basin is identified in the 303(d) list of water quality impaired waters (ODEQ 1998). Water bodies included in this list do not meet standards developed under the Clean Water Act by the U.S. Environmental Protection Agency and the Oregon Department of Environmental Quality. Six of the seven bull trout streams identified in the 1997 listing exceed temperature standards established for bull trout (10 degrees Celsius [50 degrees Fahrenheit]). Threemile Creek is on the 303(d) list because of habitat modification.

Because the geology of the basin includes highly erodible soils, fine sediment is present to some degree in most of the basin's bull trout streams (Buchanan *et al.* 1997). In high-gradient reaches typical of streams presently inhabited by bull trout, gravel is not abundant, and its distribution is limited to small patches in depositional areas (Light *et al.* 1996). Spawning adult bull trout prefer sites where substrate is not highly compacted (McPhail and Murray 1979) and where fine sediments do not reduce the quality of spawning gravels.

In the professional judgment of the recovery unit team, elevated water temperatures and sedimentation are significant threats to long-term persistence of bull trout in the Klamath River Recovery Unit.

Dams

Passage at dams that may prevent bull trout from re-establishing connectivity within and between the three core areas will need to be addressed for recovery. Streams with dams and diversions that need assessment for fish passage have been identified in the *Klamath River Basin, Oregon Fish Management Plan* (ODFW 1997). Listed bull trout stream systems with dams or diversions include Deming Creek, the Sprague River (mainstem, North Fork, and South Fork), and the Sycan River, including the Sycan Marsh.

A single, small hydroelectric facility on the North Fork Sprague River, approximately 12.9 kilometers (8 miles) north-northeast of the town of Bly, Oregon, threatens fry and small juvenile bull trout with potential impingement and entrainment at the headstock. Terrain roughness and stream gradient and flow have prevented surveys of the canyon reaches above the facility. However, adult bull trout have been observed two miles above.

The water control structure located on the Williamson River in Chiloquin, Oregon, could become a potential migratory barrier if fluvial or adfluvial populations of bull trout are reestablished in the Upper Klamath Lake and Upper Sprague River core areas. The existing fish ladder is in poor repair.

Dams and water control structures do not currently appear to present a significant threat to bull trout in the Klamath River basin. However, in the professional judgment of the recovery unit team, the degree of threat posed by these structures will undoubtedly change as abundance and distribution of local and migratory populations of bull trout increase in response to recovery actions.

Forest Management Practices

Logging and road-building activities affect bull trout through increased sediment production and delivery to streams, loss of large pools, increased temperatures, and loss of large woody debris. Low in-channel complexity and the loss of streamside vegetation have had significant impacts on bull trout and their habitat.

Surveys in bull trout streams in the Klamath River basin have shown that levels of fine sediments were moderate to high (Dambacher 1995; Light *et al*. 1996; Weyerhaeuser 1994). Quigley and Arbelbide (1997) noted that average road densities in bull trout watersheds were 0.28 kilometers per square kilometer (0.45 mile per square mile), a density considerably less than the 1.23 to 1.89 kilometers per square kilometer (2 to 3 miles per square mile) reported as adequate for other salmonids.

Past timber harvest practices have removed large trees from riparian zones outside of Wilderness and U.S. National Park boundaries. This tree removal has decreased shade and the availability of large woody debris, both important components of high-quality fish habitat (Light *et al*. 1996). Reduced shade resulting from timber harvest and close proximity of roads can be found along Dixon, Boulder, and Threemile Creeks (Dambacher 1995; Light *et al*. 1996). There may also be a strong correlation between increased temperatures and adverse effects of nonnative brook trout (Buchanan *et al.* 1997). For example, brook trout are more tolerant of warmer temperatures than bull trout are, and loss of shade has been linked to warmer stream temperatures (Howell and Buchanan 1992).

Large woody debris serves an important function in fish habitat. It creates pools, increases structural complexity, provides fish cover, traps gravel for spawning and for invertebrate production, holds other organic matter, and increases channel stability (Griffith 1993). In bull trout-occupied streams in the Klamath River basin, the abundance of large woody debris is considered moderate to low (Light *et al*. 1996; Buchanan *et al.* 1997). Past forest management often included removing large woody debris from stream channels in an effort to minimize culvert blockage and flooding. In Brownsworth Creek and the lower reaches of Cherry, Threemile, and Sevenmile Creeks, habitat complexity has been reduced by such stream channel clean-out. In the upper Sycan River drainage, large wood is lacking in portions of Paradise Creek, Watson Creek, and the lower Sycan River above the marsh (Light *et al*. 1996).

Pools are important summer and winter habitat for both adult and juvenile bull trout. Decreased pool frequency and increased bank erosion can result from land management practices, such as the reduction of roughness elements (large woody debris), or from natural disturbance. Lower-than-expected pool frequency is common within middle and lower reaches of most of the bull trout streams in the Klamath River basin (Weyerhaeuser 1994, 1995).

Stream shade is generally moderate throughout bull trout habitat in the Klamath River basin. Although low levels of shade can occur naturally in bull trout habitat, areas where reduced shade is the result of management activities (timber harvest, livestock grazing, and roads) are found in all managed watersheds. In some areas where riparian vegetation has been removed or suppressed, plant communities have been considerably altered.

In the professional judgment of the recovery unit team, the effects of watershed disruption (such as increased sedimentation, low channel complexity, loss of streamside and upland vegetation, decreased pool frequency, reduced large woody debris, and increased runoff) from past and current forest management practices are a significant threat to the long-term persistence of bull trout in the Klamath River basin.

Livestock Grazing

Cattle grazing has had a strong influence on riparian vegetation and stream bank stability in the Klamath River basin. Historical records from the Bureau of Indian Affairs and the U.S. Forest Service show heavy livestock grazing from 1911 to the 1950's (Buchanan *et al.* 1997).

Grazing in riparian areas has resulted in localized areas of decreased bank stability, increased sediment loadings, and removal of the vegetative cover that provides shade for most of the bull trout streams in the basin (Dambacher 1995; Light *et al*. 1996). Grazing appears to have resulted in the increased delivery of fine sediments in meadow areas like Long and Calahan Creeks. Surveys in Brownsworth Creek found some pool volume has been lost by filling with fine sediments (Weyerhaeuser 1995). Many streams in the North Fork Sprague River and upper Sycan River drainages are deficient in pools, especially large pools.

Although livestock grazing has been either eliminated or considerably reduced along most bull trout-occupied stream reaches, grazing and its associated impacts still occur upstream and downstream of known habitat and in historically occupied and potentially restorable drainages. In the professional judgment of the recovery unit team, the success of bull trout recovery in the Klamath River basin will be significantly impaired without curtailing or strictly managing livestock grazing in unoccupied and restorable habitat.

Agricultural Practices

Water withdrawals for irrigation are common features throughout the Klamath River basin. Agricultural diversions are present on four of the seven headwater drainages occupied by bull trout (Long, Deming, Threemile, and Sun Creeks) (Buchanan *et al.* 1997). Although these diversions are located downstream of bull trout-occupied habitat, they have altered stream courses and habitat, effectively reducing their suitability as bull trout habitat and contributing to habitat fragmentation.

A more direct consequence of water withdrawals exists where unscreened diversions can result in the transport of fish into irrigation canals and therefore to fish mortality. For example, in Deming Creek, depending on the season and demand, 100 percent of the stream flow may be diverted for agricultural purposes, resulting in dewatering of the natural channel and stranding of fish below the diversion.

Lower reaches of Threemile Creek flow through private property and have been diverted and channelized for agricultural purposes. These changes have resulted in habitat fragmentation, loss of riparian vegetation, elevated water temperatures, and habitat degradation.

Unscreened diversions and water control structures fragment habitat and isolate bull trout by creating barriers to fish movement. Below Crater Lake National Park, Sun Creek passes through State forest and privately owned lands. Once Sun Creek enters private lands, it is heavily channelized and diverted for agricultural purposes (Light *et al*. 1996). In addition, no diversions are screened. In the Sycan Marsh, water control structures may prevent bull trout from utilizing otherwise available habitat in the upper and lower Sycan River.

In the professional judgment of the recovery unit team, water control structures and agricultural diversions have contributed to the decline of bull trout in the Klamath River basin. Without ensuring adequate water flow, screens at diversions, and passage at water control structures, these structures will continue to impede recovery of bull trout in the Klamath River Recovery Unit.

Transportation Network

In roaded areas, culverts at road crossings are common barriers, limiting fish movement during some life history stages or seasons. Most culverts that affect bull trout in the Klamath River basin are found downstream of currently occupied habitat. Culverts in bull trout-occupied habitat that have been identified as barriers include U.S. Forest Service Road 3413-110 at Threemile Creek and the crossing of Brownsworth Creek by U.S. Forest Service Road 034 (C. Speas, Fremont National

Forest, pers. comm., 2001). Passage issues have also been identified on the North Fork Sprague River and on Yaden, Boulder, Cold, Dead Cow, Gold, and Sheepy Creeks (C. Speas, pers. comm., 2001).

An inventory of road/stream crossings conducted by the Fremont National Forest (C. Speas, pers. comm., 2001) has determined that nearly 80 percent of the culverts within the upper Sycan River drainage are barriers to fish movement. Nearly 161 kilometers (100 miles) of road, mainly those that are hydrologically connected and those within riparian habitat, need to be closed and/or removed (C. Speas, pers. comm., 2001) in order to improve watershed condition.

Bull trout are more streambed-oriented than other salmonids. The filling of boulder/cobble interstices with fine sediment reduces the gaps between cobble used by small fish in both summer and winter. Roads, including their building, maintenance, and use, affect bull trout through increased sediment production and delivery. Fine sediments can be reduced by decommissioning roads within riparian habitat and minimizing the effects on groundwater hydrology by those roads that must be maintained in the watersheds. U.S. Forest Service Road 3413, which parallels Threemile Creek, is a significant source of fine sediment. U.S. Forest Road 400, alongside Long Creek, has shown significant erosion into the stream. Other locations where fine sediment is a concern include the middle and lower reaches of Brownsworth, Leonard, Coyote, Calahan, and Deming Creeks.

Impassable culverts and increased sedimentation have contributed to the decline of bull trout in the Klamath River Recovery Unit. In the professional judgment of the recovery unit team, impassable culverts and other barriers to movement are a significant cause of isolation and fragmentation of habitat and of the loss of genetic exchange within and between local populations of bull trout. Increased sedimentation is a significant threat to survival of eggs, fry, and juvenile bull trout.

Mining

Mining of gravel from streams, for use in construction, has occurred in the Klamath River basin, but the extent to which this mining has occurred in bull trout streams is unknown.

Residential Development

Residential development has not been an issue in the Klamath River basin.

Fisheries Management

Introduced species (Table 3) also influence bull trout populations. Some introductions like kokanee (*Oncorhynchus nerka*) may inadvertently benefit bull trout by providing forage. Other nonnative species (*e.g.*, brown, brook, and lake trout) are thought to depress or replace bull trout populations (Dambacher *et al*. 1992; Ratliff and Howell 1992; Howell and Buchanan 1992; Donald and Alger 1993; Leary *et al*. 1993). Between 1926 and 1971, 275,000 brook trout were introduced into Sun Creek in Sun Meadow (above Sun Falls) and outside the Crater Lake National Park boundary. By 1989, bull trout abundance in the park was reduced to approximately 100 to 300 adult fish (Buktenica 1997).

Table 3. Nonnative fish species introduced into the Klamath River basin (ODFW 1997).

Coldwater Game Fish	Warmwater Game Fish	Nongame Fish
Brook trout (*Salvelinus fontinalis*)	Largemouth bass (*Micropterus salmoides*)	Fathead minnow (*Pimephales promelas*)
Brown trout (*Salmo trutta*)	White crappie (*Pomoxis annularis*)	Golden shiner (*Notemigonus crysoleucus*)
Lake trout *(Salvelinus namaycush)*	Black crappie (*Pomoxis annularis*)	Mosquito fish (*Gambusia affinis*)
Kokanee salmon (*Oncorhynchus nerka kennerlyi*)	Sacramento perch (*Archoplites interuptes*)	Goldfish (*Carassius auratus*)

Coldwater Game Fish	Warmwater Game Fish	Nongame Fish
Lahontan cutthroat trout (*Onchorhynchus clarki kenshawi*)	Bluegill (*Lepomis machrochirus*)	
White sturgeon (*Acipenser transmontanus*)	Pumpkinseed (*Lepomis gibbosis*)	
Domestic rainbow (*O. mykiss*)	Green sunfish (*Lepomis cyanellus*)	
	Yellow perch (*Perca flavescens*)	
	Brown bullhead (*Ictalurus nebulosis*)	
	Channel catfish (*Ictalurus punctatus*)	

Sex ratios from spawning adult bull trout in Deming and Leonard Creeks favored males (54 to 67 percent) with lengths of 140 millimeters (5.5 inches) or greater (Rode 1990). The average size of female spawners was small (175 millimeters [6.8 inches]), and fecundity averaged 170 eggs per female. Average fecundity of resident bull trout from Sun Creek in 1947 was 249 eggs, and females averaged 181 millimeters (7.1 inches) (OCAFS 1993). These data suggest that resident Klamath River basin bull trout have a low reproductive potential (Buchanan *et al.* 1997).

Hybridization with introduced brook trout is considered a serious threat to bull trout (Dambacher *et al*. 1992; Kanda *et al*. 1992; Leary *et al*. 1993). Life history differences between the two species, such as the higher reproductive potential of book trout, favor the brook trout and can lead to displacement of bull trout, especially when these differences are combined with habitat degradation (Hobbs and Huenneke 1992; Leary *et al*. 1993).

The occurrence of brook trout X bull trout hybrids has been clearly documented (Markle 1992; Kanda 1998). Dunsmoor and Bienz (*in litt.* 1997) observed that hybrids are aggressive, larger than resident bull trout, and may provide significant competition. The threat of hybridization and of hybrids replacing bull trout is probably greater where larger, more fecund migratory forms of bull trout have been eliminated (Rieman and McIntyre 1993). In addition, interactions such as predation and competition are not well understood.

Brown trout, which are indigenous to Europe, were introduced to the Sprague River system in the 1930's (Weyerhaeuser 1995). Brown trout could be interacting with native fish in ways that may limit the native fish range and density in the watershed (Weyerhaeuser 1995). The likely mechanism for brown trout limiting native bull trout populations is by competitive exclusion. Evidence for this potential interaction is mainly from adfluvial bull trout in Montana and elsewhere (Leary *et al.* 1993; MBTRG 1996). The competitive advantage that brown trout have over brook trout has been demonstrated by several authors (Fausch and White 1981; Wang and White 1994). Generally, brown trout are more aggressive than native trout and can displace other native and nonnative salmonids. Brown trout may be better adapted to modified habitat with elevated water temperatures, providing them with a competitive advantage over bull trout (MBTRG 1996).

Displacement by nonnative salmonids has been recognized as an important factor in the decline of bull trout. The decline of native salmonids and their replacement by nonnative salmonid species has been extensively documented throughout the Intermountain West, including Idaho, Alberta, Montana, and California (Carl 1984; Weaver and White 1985; Rode 1990). A similar situation has been documented in the Klamath River basin (Ziller 1992), with brook trout and brown trout displacing bull trout. Upper Klamath River bull trout streams that have brook trout include Threemile, Sun, and Long Creeks. Brook trout are present in most streams formerly occupied by bull trout, including Cherry and Sevenmile Creeks. Brown trout are now found in many bull trout streams, including Boulder and Brownsworth Creeks and the Sprague River.

Although the Oregon Department of Fish and Wildlife has closed fishing for bull trout in the Klamath River basin and the use of bull trout streams by fishermen angling for other species is considered low (R. Smith, pers. comm., 1999; OSP, *in litt.,* 2000), illegal harvest could rapidly deplete local populations of bull trout in the Klamath River basin because population sizes are limited and bull trout are particularly susceptible to angling (Carl 1984; Boag 1987). Current fishing regulations, with a 20.3-centimeter (8-inch) minimum length for trout (ODFW 1999), may not prevent take of spawning-size bull trout by anglers because they might not recognize the fish or some may disregard regulations. Angling can be a significant threat in streams with small populations of bull trout, such as Threemile, Boulder, and Dixon Creeks, where the removal of even a few spawning-age fish could significantly reduce the number of effective spawners.

Although fish identification posters have been placed alongside bull trout-inhabited streams in the Klamath River basin, the frequency of occurrence is low. The posters depict large migratory forms that are uncommon in the Klamath River basin instead of resident forms that anglers are more likely to encounter. Additionally, the inks used to print the identification posters are not colorfast and have faded, bleached, and changed color from exposure to the sun, making the identifying features of the fish difficult to decipher.

The threat from illegal angling is not currently considered significant. It does, however, have the potential of becoming a significant issue on bull trout steams that have small, threshold populations. While competition between bull trout and nonnative species has undoubtedly been a contributing factor in the decline of bull trout in the Klamath River basin, the level and complexity of threat is not well understood and is a subject for further research. In the professional judgment of the recovery unit team, hybridization with nonnative species is a very significant threat and has been a major contributor to the decline of bull trout in the Klamath River Recovery Unit.

Isolation and Fragmentation

Natural barriers to bull trout distribution (*e.g.*, high-gradient areas and waterfalls) are features of headwater reaches and occur most often at the upstream limits of distribution. Streams with stretches where flows become intermittent (*e.g.*, Cherry, Threemile, Boulder, and Hammond Creeks) present barrier limits or compress fish distribution during periods of intermittent or low flows. These effects vary depending on annual precipitation in these drainages.

Within the Klamath River basin, natural barriers that exclude nonnative salmonids from bull trout reaches are rare. Volcanic deposits have isolated Deming Creek fish from the rest of the Klamath River basin: the porous material allows water to flow below the surface, preventing fish movement. Although such a barrier has prevented nonnative species from invading the Deming Creek drainage, it has also prevented bull trout from expressing migratory behavior.

Extensive migrations are characteristic of bull trout. Connectivity between headwater streams allows genetic exchange to take place, for example, because bull trout can move during foraging, breed in different streams, and move into unoccupied habitat (Light *et al*.1996), the latter having occurred in Sheepy and Coyote Creeks.

Thermal limits to bull trout distribution may be a factor in several locations in the Klamath River basin. Lower-elevation streams may have not been hospitable for bull trout, even historically. However, sections of the North and South Forks of the Sprague River, uninhabited by bull trout now, were probably inhabited historically. The extensive wetlands of the Klamath and Sycan Marshes may have been marginal or intermittent habitat historically, but many tributary systems, as evidenced by Long and Coyote Creeks, were probably inhabited.

In summary, because bull trout populations in the Klamath River basin are small, isolated, and threatened with extinction, any land or resource actions leading to changes in or disruptions to watershed processes in occupied, historic, and potential habitat must be minimized in efforts to recover Klamath River basin bull trout to a level at which they can be delisted. Significant threats to the long-term persistence of bull trout in the Klamath River basin include sedimentation, low in-channel complexity, elevated water temperatures, competition and hybridization with nonnatives, barriers to movement, habitat isolation and fragmentation, and agricultural water diversions.

ONGOING RECOVERY UNIT CONSERVATION MEASURES

The Klamath Basin Bull Trout Working Group formed in 1989. It is composed of representatives from the U.S. Fish and Wildlife Service, Crater Lake National Park, Fremont and Winema National Forests, Klamath Tribes, Oregon Department of Fish and Wildlife, U.S. Timberlands, The Nature Conservancy, Oregon Chapter of the American Fisheries Society, PacifiCorp, U.S. Bureau of Reclamation, Sprague River Water Association, and Klamath Basin Water Users Protective Association. The working group developed, and has been implementing, a conservation strategy for bull trout in the Klamath River basin (Light *et al*. 1996). The goal is to protect and enhance bull trout populations throughout the basin.

The Klamath Basin Bull Trout Conservation Strategy has developed a two-phased approach to conserving bull trout. Phase I addresses biotic and abiotic factors that threaten the persistence of these populations. The presence of nonnative trout and of habitat degradation and alteration have been identified as the most immediate threats to bull trout within the Klamath River basin. Habitat enhancement is considered generally feasible, particularly in areas where roads or livestock grazing are threats. Suppressing and removing nonnative fish may prove difficult to sustain over time.

The intent of Phase II is to reestablish bull trout populations in headwater streams that now support nonnative trout only. Expanding bull trout into historical range will expand the number of local populations.

Recent conservation measures within the Klamath River basin (Table 4) have included: excluding cattle from stream riparian areas occupied by bull trout; surveying population and habitat; treating and obliterating roads near bull trout streams to control and eliminate sediment sources; and reducing timber harvest/woodcutting within riparian zones. Restoration projects by the Klamath Basin Bull Trout Working Group are also focused on reducing and eradicating nonnative species in native bull trout habitat.

Table 4. Completed, ongoing, and planned conservation measures of the Klamath Basin Bull Trout Working Group.

Conservation Measure	Status[a]
Bull trout sportfishing harvest in Klamath River basin closed (ODFW)	1991
Watershed analysis of Boulder Creek completed (U.S. Timberlands)	1993
Watershed analysis of Long Creek completed (U.S. Timberlands)	1993
Agreements made with U.S. Timberland to fence, remove, and exclude cattle from bull trout-occupied habitat	1994
Watershed analysis of Brownsworth Creek completed (U.S. Timberlands)	1995
Watershed analysis of Leonard Creek completed (U.S. Timberlands)	1995
Watershed analysis of Hammond Creek completed (U.S. Timberlands)	1995
Watershed analysis of Threemile Creek completed (Winema NF)	1995
Klamath Basin Bull Trout Working Group Conservation Strategy document completed	1996
Klamath Basin Bull Trout Working Group Coordinator hired	1996
Watershed analysis of Coyote Creek completed (U.S. Timberlands)	1996
Boulder Creek culverts replaced (U.S. Timberlands)	1996
Dixon Creek culvert replaced (U.S. Timberlands)	1996
Barrier enhancement project on Long Creek completed	1996
Genetic material from Klamath Basin bull trout populations collected	1996
Klamath Basin bull trout habitat evaluation surveys completed	1996
Boulder Creek road obliterated and seeded	1996
Bull trout watersheds in Winema NF designated as Tier 1 under National Forest Plan	1996
Road adjacent to Brownsworth Creek decommissioned	1997
Lost Creek (Crater Lake National Park) treated with antimycin	1997
Environmental assessment data collected from Threemile, Long, and Calahan Creeks (amphibian, macroinvertebrate, mollusks, water flow, and water quality surveys)	1998
Brook trout removed from fire pool/catchment in upper Threemile Creek watershed	1998
Sun Meadow (Crater Lake National Park) treated with antimycin	1998
Thermograph units placed in Threemile, Long, Calahan, and Brownsworth Creeks	1998
Fish regulation/identification signs placed	1998
Puck Lake connectivity survey conducted	1998

Conservation Measure	**Status**[a]
Deming Creek road decommissioned	1999
Bull trout radio-tagged in Long Creek	1999
Angling closed on Threemile Creek above Westside Road (ODFW)	2000
Genetic sampling done of bull trout in Threemile Creek and Sun Creek (Winema NF)	2000
Section 7 Biological Assessment done of Winema NF ongoing and proposed actions in bull trout watersheds (Winema NF)	2000
Removal of brook trout in Threemile Creek (electrofishing/snorkel/spearfishing)	Ongoing
Removal of brook trout in Long Creek (electrofishing/snorkel/spearfishing)	Ongoing
Analysis of Environmental Assessment data from Threemile, Long, and Calahan Creeks	Ongoing
Removal of brown trout in Brownsworth Creek	Ongoing
Presence/absence, distribution surveys on State, Federal, and private lands, including lower Threemile, Coyote, Sheepy, Brownsworth, Leonard, Dixon, Sun, Annie, and Sevenmile Creeks	Ongoing
Seasonal spawning ground surveys	Ongoing
Long Creek radio telemetry study	Ongoing
Habitat surveys	Ongoing

[a] Ongoing activities or the year the activity was completed.

An intensive program to remove brook trout from bull trout-occupied reaches of Threemile Creek has been ongoing since 1996. Brook trout removal was also initiated in Long Creek in 1998, and opportunistic removal of brown trout began in Brownsworth Creek in 2000. Also in 2000, bull trout in Sun Creek were captured and held in raceways while the stream was treated with antimycin to remove brook trout. Young-of-year fry were held in hatchery facilities until they grew large enough to be positively identified to species. Eighty-five were released back into their native habitat during 2001.

In addition to Threemile, Long, Brownsworth, and Sun Creeks, many other areas require removal of nonnative fish, including 1) tributaries to the Sycan Marsh and the upper Sycan River (*e.g.*, Coyote Creek) and 2) the North and South Forks of the Sprague River and tributaries (*e.g.*, Boulder, Dixon, and Leonard Creeks).

Although the Oregon Department of Fish and Wildlife closed angling for bull trout in the Klamath River basin in 1991 and angling usage in Threemile Creek appears to be light, the Klamath Basin Bull Trout Working Group has been concerned about the threat of incidental harvest on this population. In response to the working group's concerns, the Oregon Department of Fish and Wildlife closed angling on Threemile Creek in 2000, the best method to address the threat of incidental take on such a small population. The Winema National Forest is currently analyzing a proposed action to obliterate 3.2 kilometers (2.0 miles) of road paralleling Threemile Creek.

Oregon State Police angler surveys, especially those conducted during the hunting season when there is a higher incidence of angling taking place in conjunction with hunting trips, indicate that angling activity in the Klamath River basin is low to nonexistent (OSP, *in litt.,* 2000, 2001). Nevertheless, Oregon Department of Fish and Wildlife and the Oregon State Police, through the Cooperative Enforcement Program, continue to give Klamath River basin bull trout streams high priority for law enforcement patrol.

STRATEGY FOR RECOVERY

A core area represents the closest approximation of a biologically functioning unit for bull trout. The combination of core habitat (*i.e.*, habitat that could supply all elements for the long-term security of bull trout, including for both spawning and rearing, as well as for foraging, migrating, and overwintering) and a core population (*i.e.*, bull trout inhabiting core habitat) constitutes the basic core area upon which to gauge recovery within a recovery unit. Within a core area, many local populations may exist. Core areas for bull trout recovery in the Klamath River basin occur in three distinct watersheds: the Upper Klamath Lake core area; the Sycan River core area; and the Upper Sprague River core area (Figure 2).

Recovery Goals and Objectives

The goal of the bull trout recovery plan is to **ensure the long-term persistence of self-sustaining, complex interacting groups of bull trout distributed across the species native range, so that the species can be delisted**. To recover bull trout in the Klamath River Recovery Unit, the following objectives need to be met:

- Maintain current distribution of bull trout and restore distribution in previously occupied areas within the Klamath River Recovery Unit, as noted in Appendix A.

- Maintain stable or increasing trends in abundance of bull trout within the Klamath River. This objective includes the expression of all life history strategies, including resident, fluvial, and

  adfluvial forms in the Upper Klamath Lake core area and resident and fluvial forms in the Sycan River and Upper Sprague River core areas.

- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies. Stable or upward trends in habitat quality in core areas and migration corridors are achieved through landscape-level adjustments in land management strategies designed to maintain and/or enhance structural and functional attributes of upslope, riparian, and fluvial systems.

- Conserve genetic diversity and provide opportunity for interchange of genetic material among appropriate core populations.

Rieman and McIntyre (1993) and Rieman and Allendorf (2001) evaluated the bull trout population numbers and habitat thresholds necessary for long-term viability of the species. They identified four elements, and the characteristics of those elements, to consider when evaluating the viability of bull trout populations. These four elements are (1) number of local populations; (2) adult abundance (defined as the number of spawning fish present in a core area in a given year); (3) productivity, or the reproductive rate of the population (as measured by population trend and variability); and (4) connectivity (as represented by the migratory life history form and functional habitat). For each element, the Klamath River Recovery Unit Team classified bull trout into relative risk categories based on the best available data and the professional judgment of the team.

The Klamath River Recovery Unit Team also evaluated each element under a potential recovered condition to produce recovery criteria. Evaluation of these elements under a recovered condition assumed that actions identified within this chapter had been implemented. Recovery criteria for the Klamath River Recovery Unit reflect (1) the stated objectives for the recovery unit, (2) evaluation of each population element in both current and recovered conditions, and (3) consideration of current and recovered habitat characteristics within the recovery unit. Recovery criteria will probably be revised in the future as more detailed information on bull trout population dynamics becomes available. Given the limited information on bull trout, both the level of adult abundance and the number of local populations needed to lessen the risk of extinction should be viewed as a best estimate.

This approach to developing recovery criteria acknowledges that the status of populations in some core areas may remain short of ideals described by conservation biology theory. Some core areas may be limited by natural attributes or by patch size and may always remain at a relatively high risk of extinction. Because of limited data within the Klamath River Recovery Unit, the recovery unit team relied heavily on the professional judgment of its members.

Local Populations

Metapopulation theory is important to consider in bull trout recovery. A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994) (see Chapter 1). Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events. In part, distribution of local populations in such a manner is an indicator of a functioning core area. Based in part on guidance from Rieman and McIntyre (1993), bull trout core areas with fewer than 5 local populations are at increased risk, core areas with between 5 and 10 local populations are at intermediate risk, and core areas with more than 10 interconnected local populations are at diminished risk.

Current local populations in the Klamath River Recovery Unit are 1) Upper Klamath Lake core area: Threemile Creek, Sun Creek, and Lost Creek; 2) Sycan River core area: Long Creek and Coyote Creek; 3) Upper Sprague River core area: Deming Creek, Boulder-Dixon Creek, Brownsworth Creek, Leonard Creek, North Fork Sprague River, and Sheepy Creek. Using the above guidance for assessing risk, if all local populations were interconnected, bull trout in the Klamath River Recovery Unit would be at diminished risk. Resident bull trout are known to occur within the recovery unit. However, an accurate description of their current distribution is unknown, and the identification of resident local populations is considered a research need.

Adult Abundance

The recovered abundance levels in the Klamath River Recovery Unit were determined by considering theoretical estimates of effective population size, historical census information, and the professional judgment of recovery team members. In general, effective population size is a theoretical concept that allows us to predict potential future losses of genetic variation within a population due to small population sizes and genetic drift (see Chapter 1). For the purpose of recovery planning, effective population size is the number of adult bull trout that successfully spawn annually. Based on standardized theoretical equations (Crow and Kimura 1970), guidelines have been established for maintaining minimum effective population sizes for conservation purposes. Effective population sizes of greater than 50 adults are necessary to prevent inbreeding depression and a potential decrease in viability or reproductive fitness of a population (Franklin 1980). To minimize the loss of genetic variation due to genetic drift and to maintain constant genetic variance within a population, an effective population size of at least 500 is recommended (Franklin 1980; Soule 1980; Lande 1988). Effective population sizes required to maintain long-term genetic variation that can serve as a reservoir for future adaptations in response to natural selection and changing environmental conditions are discussed in Chapter 1 of the recovery plan.

For bull trout, Rieman and Allendorf (2001) estimated that a minimum number of 50 to 100 spawners per year is needed to minimize potential inbreeding effects within local populations. In addition, a population size of between 500 and 1,000 adults in a core area is needed to minimize the deleterious effects of genetic variation from drift.

For the purposes of bull trout recovery planning, abundance levels were conservatively evaluated at the local population and core area levels. Local populations containing fewer than 100 spawning adults per year were classified as at risk from inbreeding depression. Bull trout core areas containing fewer than 1,000 spawning adults per year were classified as at risk from genetic drift.

Overall, bull trout in the Klamath River Recovery Unit persist at low numbers in fragmented local populations. Evaluation of genetic risks for local populations and core areas was based on the aforementioned guidance, and available adult abundance estimates (Table 2). In cases where specific adult population estimates were lacking, local populations and core areas were conservatively considered at risk from inbreeding and drift, respectively.

In the Upper Klamath Lake core area, Threemile Creek has an estimated adult abundance of 45 individuals which would place this local population at risk from inbreeding depression. While Sun Creek represents one of the strongest local populations in the Upper Klamath core area, the lack of recent adult abundance estimates placed precluded the evaluation of inbreeding depression risk for this local population. Similarly, evaluation of genetic risk at the local population level for bull trout in Lost Creek was prevented by a lack of adult abundance information. Based on available information, the Upper Klamath Lake core area may contain less than 1,000 adult bull trout and should be considered at risk from genetic drift.

Within the Sycan River core area, limited data on adult abundance within Coyote Creek conservatively placed this local population at risk from inbreeding. Estimates for adult abundance in Long Creek suggest that this local population may not be at risk from inbreeding depression (Table 2). Overall the Sycan River core area should be considered at risk from the deleterious effects of genetic drift.

Bull trout within the Upper Sprague core area may represent some of the strongest remaining local populations in the Klamath recovery unit. Based on available information, the local populations in Brownsworth, Deming, and Leonard creeks are not at risk from inbreeding depressions. However, local populations within the North Fork Sprague River, Boulder-Dixon and Sheepy creeks are considered to be at risk from inbreeding depression. Overall, if all local populations were connected, the Upper Sprague River core area would not be at risk from genetic drift.

Productivity

A stable or increasing population is a key criterion for recovery under the requirements of the Endangered Species Act. Measures of the trend of a population (the tendency to increase, decrease, or remain stable) include population growth rate or productivity. Estimates of population growth rate (*i.e.*, productivity over the entire life cycle) that indicate a population is consistently failing to replace itself also indicate an increased risk of extinction. Therefore, the reproductive rate should indicate that the population is replacing itself, or growing.

Since estimates of the total population size are rarely available, the productivity or population growth rate is usually estimated from temporal trends in indices of abundance at a particular life stage. For example, redd counts are often used as an index of a spawning adult population. The direction and magnitude of a trend in the index can be used as a surrogate for the growth rate of the entire population. For instance, a downward trend in an abundance indicator may signal the need for increased protection, regardless of the actual size of the population. A population that is below recovered abundance levels, but that is moving toward recovery, would be expected to exhibit an increasing trend in the indicator.

The population growth rate is an indicator of probability of extinction. This probability cannot be measured directly, but it can be estimated as the consequence of the population growth rate and the variability in that rate. For a population to be considered viable, its natural productivity should be sufficient for the population to replace itself from generation to generation. Evaluations of population status will also have to take into account uncertainty in estimates of population growth rate or productivity. For a population to contribute to recovery, its growth rate must indicate that the population is stable or increasing for a period of time. Due to the overall lack of long-term population census information in the Klamath River Recovery Unit, the recovery unit team believes bull trout to be at increased risk.

Connectivity

The presence of the migratory life history form within the Klamath River Recovery Unit was used as an indicator of the functional connectivity of the recovery unit. If the migratory life form was absent, or if the migratory form is present but local populations lack connectivity, the core area was considered to be at increased risk. If the migratory life form persists in at least some local populations, with partial ability to connect with other local populations, the core area was judged to be at intermediate risk. Finally, if the migratory life form was present in all or nearly all local populations, and had the ability to connect with other local populations, the core area was considered to be at diminished risk. Lack of passage within the Klamath River Recovery Unit has fragmented bull trout populations and prevented migration to foraging and overwintering habitat. Lack of passage and the low abundance of migratory life history strategy also limit the possibility for genetic exchange and refounding of local populations.

Recovery Criteria

Recovery criteria for bull trout in the Klamath River Recovery Unit are the following:

1. **Maintain current distribution of bull trout in the 12 local populations that have been identified and expand distribution by establishing bull trout in areas identified as suitable for potential local populations.** The number of existing local populations by core area are: Upper Klamath Lake, 3; Sycan River, 2; and Upper Sprague River, 7 (Table 5).

Table 5. Summary of recovery criteria for the Klamath River Recovery Unit. Potential number of local populations, potential abundance, and future trend reflect minimum standards under recovered conditions.

Core Area	Current number of local populations	Current estimated abundance	Potential number of local populations	Potential abundance	Future trend
Upper Klamath Lake	3	324	5 to 7 of 17	500 to 5,000	stable to increasing
Sycan River	2	842	5 to 7 of 15	500 to 5,000	stable to increasing
Upper Sprague River	7	3,310	10 to 12 of 24	500 to 5,000	stable to increasing
3 Core Areas	12	4,476	20 to 26 of 56	8,250	stable to increasing

Table 6 presents specific local populations and areas identified as potential local populations. Achieving criterion 1 entails maintaining existing local populations and establishing additional potential local populations of all core areas in the recovery unit to achieve the maintenance of both current and recovered distribution. To achieve criterion 1 and to ensure a core area population of no fewer than 100 adult bull trout, establishing at least 5 to 7 local populations in the Klamath Lake core area among 15 potential local populations (2 to 4 new local populations), at least 5 to 7 local populations in the Sycan River core area from among 15 potential

Table 6. List of existing and proposed local populations by core area in the Klamath River Recovery Unit.

Recovery Unit	Core Area	Local Populations[a]
Klamath River	Upper Klamath Lake	Annie Creek, Cherry Creek Crooked Creek, Fort Creek, Fourmile Creek drainage, Jackson Creek, **Lost Creek** Munson Creek Nannie Creek Rock Creek Sand Creek, Scott Creek, Sevenmile Creek, Spring Creek **Sun Creek**, **Threemile Creek** Wheeler Creek
	Sycan River	Boulder Creek, Calahan Creek, Chocktoot Creek, **Coyote Creek**, Crazy Creek, Cummins Creek, Currier Creek, **Long Creek** Paradise Creek, Rifle Creek, Rock Creek, Skull Creek, South Fork Sycan River, Sycan River, Watson Creek

Table 6. List of existing and proposed local populations by core area in the Klamath River Recovery Unit.

Recovery Unit	Core Area	Local Populations[a]
	Upper Sprague River	Alder Creek, **Boulder-Dixon Creek**, **Brownsworth Creek**, Buckboard Creek, Camp Creek, Cold Creek, Corral Creek, Dead Cow Creek, **Deming Creek**, Gearhart Creek, Gold Creek, Hammond Creek, Hole Creek, Jack Creek, Jade Creek, **LeonardCreek**, Mud Creek, **North Fork Sprague River**, Nottin Creek, Pothole Creek, School Creek, **Sheepy Creek** South Fork Sprague River, Whitworth Creek

[a] Existing local populations of bull trout, or areas used seasonally by bull trout, are indicated in bold.

local populations (3 to 5 new local populations), and at least 10 to 12 local populations in the Upper Sprague River core area from among 25 potential local populations (3 to 5 new local populations) is necessary.

2. **Estimated abundance of adult bull trout is at least 8,250 individuals distributed among the Upper Klamath Lake, Sycan River, and Upper Sprague River core areas, based on 10 years of monitoring data.**

3. **Adult bull trout exhibit stable or increasing trends in abundance in the Upper Klamath Lake, Sycan River, and Upper Sprague River core areas, based on at least 2 generations (10 years) of monitoring data.**

4. **Specific barriers to bull trout migration in the Klamath River Recovery Unit are addressed.** In the Klamath River Recovery Unit, this objective means addressing passage: (1) existing culverts that impede passage should be replaced, including those on Threemile Creek at U.S. Forest Service Road 110 crossing, Brownsworth Creek at U.S. Forest Service Road 34 crossing, and Brownsworth Creek both 0.75 mile and 1.25 miles above U.S. Forest Service Road 34; the culvert 0.25 mile below U.S. Forest Service Road 34 (to prevent repeated washout); the large-diameter culvert at the Boulder Creek road crossing; culverts in the upper Sycan River watershed that are identified in the Fremont National Forest inventory; and several in the North Fork Sprague River drainage, namely, on North Fork Sprague River (2), Boulder Creek (1), Dead Cow Creek (1), and Sheepy Creek (1); (2) fish passage structures should be installed at water diversions on bull trout streams, and barriers should be removed, including on Cherry, Sevenmile, Sun, and Threemile Creeks; (3) fish screens should be installed to prevent fish from entering diversion canals or pipes, including on Long, Deming, Threemile, Sun, Sevenmile, and Cherry Creeks; 4) manmade barriers and entrainment should be evaluated and remedied to promote migratory bull trout; priority watersheds include Threemile, Long, Deming, Sevenmile, Cherry, Sun, and Long Creeks.

Recovery criteria for the Klamath River Recovery Unit were established to assess whether recovery actions are resulting in the recovery of bull trout. The Klamath River Recovery Unit Team expects that the recovery process will be dynamic and will be refined as more information becomes available. While removal of bull trout as a species under the Endangered Species Act (*i.e.*, delisting) can only occur for the entity that was listed (Columbia River distinct population segment), the criteria listed above will be used to determine when the Klamath River Recovery Unit is fully contributing to recovery of the population segment. A summary of recovery criteria standards is presented in Table 5.

Research Needs

Many uncertainties exist regarding bull trout population abundance and distribution. If effective management and recovery based on the best scientific information available are to occur, the recovery plan for the Klamath River Recovery Unit must be treated as a "living" document—it must be updated as new information becomes available. As part of an adaptive approach to management, the Klamath River Recovery Unit Team has identified a number essential research needs within the recovery unit.

Distribution

It is important to understand the current and future role of the Sycan Marsh in the persistence and recovery of bull trout. Migratory bull trout appear to use portions of the marsh at least seasonally and probably on a year-round basis. It is also essential to establish with greater certainty the current distribution and seasonal use areas of remnant migratory bull trout within the mainstem rivers within the Klamath River Recovery Unit. To this end, the recovery unit team recommends developing and applying a statistically rigorous, standardized protocol for determining distribution of bull trout. Application of such a protocol will improve the team's ability to modify existing or identify new core areas.

Specific waters mentioned in anecdotal reports of bull trout should be targeted for surveys to clarify bull trout distribution within the recovery unit. These areas include the Sycan River watershed, both above and below the Sycan Marsh, and the upper reaches of the North and South Forks of the Sprague River. Also, unoccupied habitat that has the potential to be restored and to have bull trout reestablished needs to be identified.

Pathogens

The extent of threats to Klamath River basin bull trout from pathogens and parasites is unknown. One species of myxosporean parasite, *Ceratomyxa shasta*, has been found in Klamath River drainages (Wales and Wolf 1955) and lower elevation tributaries to Klamath Lake (R. Smith, pers. comm., 2000). The distribution of *C. shasta* within the Klamath River basin is unknown. Although there is evidence to suggest that some strains of salmonids may be resistant to *C. shasta* (Schafer 1967; R. Smith, pers. comm., 2000), whether Klamath River bull trout are resistent is unknown. If bull trout are susceptible to *C. shasta*, recovery of the char beyond colder natal and mainstem drainages could be difficult. Among topics needing research are distribution of the parasite in the Klamath River basin; the degree of resistance that bull trout may posses; vectors of disease transmission; intermediate hosts, if any; and methods to control the disease.

ACTIONS NEEDED

Recovery Measures Narrative

In this chapter and all other chapters of the bull trout recovery plan, the recovery measures narrative consists of a hierarchical listing of actions that follows a standard template. The first-tier entries are identical in all chapters and represent general recovery tasks under which specific (*e.g.*, third-tier) tasks appear when appropriate. Second-tier entries also represent general recovery tasks under which specific tasks appear. Second-tier tasks that do not include specific third-tier actions are usually programmatic activities that are applicable across the species' range; they appear in *italic type*. These tasks may or may not have third-tier tasks associated with them; see Chapter 1 for more explanation. Some second-tier tasks may not be sufficiently developed to apply to the recovery unit at this time; they appear in *a shaded italic type (as seen here)*. These tasks are included to preserve consistency in numbering tasks among recovery unit chapters and intended to assist in generating information during the comment period for the draft recovery plan, a period when additional tasks may be developed. Third-tier entries are tasks specific to the Klamath River Recovery Unit. They appear in the implementation schedule that follows this section and are identified by three numerals separated by periods.

The Klamath River Recovery Unit chapter should be updated as recovery tasks are accomplished or revised as environmental conditions change and monitoring results or additional information becomes available. The Klamath River Recovery Unit Team should meet annually to review annual monitoring reports and summaries and make recommendations to the U.S. Fish and Wildlife Service.

1 Protect, restore, and maintain suitable habitat conditions for bull trout.

1.1 Maintain or improve water quality in bull trout core areas or potential core habitat.

1.1.1 Conduct watershed assessments. The U.S. Forest Service (USFS), National Park Service (NPS), Bureau of Land

Management (BLM), Oregon Department of Forestry (ODF), U.S. Timberlands (UST), and The Nature Conservancy (TNC) should conduct thorough surveys of sediment sources and channel stability (watershed analysis) in all bull trout watersheds within their respective areas of responsibility. If a watershed contains lands under the responsibility of more than one entity, all parties should jointly conduct the watershed analysis. The watershed analysis should include a reassessment of previous road closures and treatments for their effectiveness; identification of skid trails, roads, and landings that are no longer needed; an evaluation of hydrographic regime; and a review of land and resource management activities and their impacts on watershed function. Roads that need to be hydrologically improved and/or decommissioned should also be identified (*e.g.*, Deming Creek and Threemile Creek).

1.1.2 Monitor sediment loading in current and potential bull trout habitat. Because these creeks either currently support bull trout or have a high probability of supporting them following the implementation of restoration and conservation measures, the land use management agencies should routinely monitor sediment loading to minimize potential for adverse impacts to bull trout.

1.1.3 Reduce general sediment sources. All roads, crossings, and other sources of sediment delivery should be stabilized. Potential sites include U.S. Forest Service Road 3413 along Threemile Creek; U.S. Forest Service Road 103 adjacent to Brownsworth Creek; U.S. Forest Service Road 400 along Long Creek; roads and sediment sources on Calahan, Coyote, Deming, Boulder, Leonard, and Cherry Creeks; and bank stability along Paradise and Watson Creeks and the lower Sycan River.

1.1.4 Modify roads and trails to allow natural drainage patterns. Trails that channel water or block side channels should be modified in all watersheds by the respective land use management entity.

1.1.5 Conduct limiting factors analysis for impact of roads. Identify roads that are susceptible to mass wasting and bank failures, intercept surface or ground water, negatively impact riparian areas, and inhibit connectivity and natural stream function. Implement corrective actions where appropriate. Road density in bull trout watersheds should be reduced to less than 1.0 mile per square mile with few roads in valley bottoms.

Prospective road candidates include approximately 100 miles of roads within the Fremont National Forest within the upper Sycan River drainage that have hydrological connection or are within riparian areas, as well as U.S. Forest Service Road 3413, from 3413-110 to its connection with U.S. Forest Service Road 3449, on the Winema National Forest along Threemile Creek. A 50 percent reduction in road density within the Threemile Creek and Sevenmile Creek watersheds should be achieved. The 3208-105 spur should be permanently closed and rehabilitated. Alternatives to retaining the Sevenmile Creek trailhead and campground should be developed and implemented. The campground and road are immediately adjacent to the stream channel, and both contribute sediment directly into the creek. Supports for the washed-out bridge are still within the stream channel and should be removed.

1.1.6 Monitor baseline instream habitat and watershed conditions. On a regular schedule, instream habitat and watershed conditions should be monitored and resulting recommendations implemented through adaptive management to reduce impacts from land and resource management actions.

1.1.7 Assess nutrient input from forestry and agriculture. The effects of nutrient enrichment from forestry and agriculture should be addressed by all land managers within their respective areas of responsibilities.

1.1.8 Implement measures to reduce nutrient input. Measures to reduce the introduction of nutrient enrichment that is identified through assessment of forestry and agriculture practices should be implemented as soon as possible. Some of these measures are limiting or removing agriculture and livestock grazing immediately adjacent to streams and waterways, establishing buffer zones between waterways and agriculture and grazing, and restoring natural streamside and riparian plant communities.

1.1.9 Implement water quality regulations. Encourage rapid implementation of total maximum daily load (known as TMDL) standards for current and potential bull trout waters included in the 303(d) list of impaired water bodies. These include currently occupied reaches of Threemile Creek (listed for habitat) and Deming, Boulder, Leonard, Brownsworth, Long, and Sun Creeks (listed for temperature).

1.1.10 Increase water quality monitoring. A detailed water quality monitoring plan developed by the respective land use entity, with oversight from the Klamath Basin Bull Trout Working Group, should be implemented for all watersheds having known populations of bull trout and in streams considered potential local populations (Table 5) to refine the water quality requirements for bull trout and to provide corrective action, should it be necessary, as soon as possible.

1.1.11 Increase enforcement of water quality standards. In all streams with known bull trout populations and in all streams considered potential local populations (Table 5), all land use managers should ensure that water quality standards are being met within their areas of responsibility, and the Oregon Department of Environmental Quality should enforce all water quality standards, including newly completed total maximum daily loads (TMDLs).

1.2 Identify barriers or sites of entrainment for bull trout and implement tasks to provide passage and eliminate entrainment.

1.2.1 Investigate methods to improve instream flows. Land use managers should investigate methods to increase water retention and slow runoff in watersheds exhibiting low or intermittent stream flows in streams like Rock, Cherry, Threemile, Boulder, and Hammond Creeks.

1.2.2 Implement measures to improve instream flows. Land use managers should implement measures to increase water retention and slow runoff in watersheds exhibiting low or intermittent stream flows in streams like Rock, Cherry, Threemile, Boulder, and Hammond Creeks.

1.2.3 Monitor all road crossings. All road crossings should be routinely monitored by respective land use managers to identify blockages to upstream passage.

1.2.4 Eliminate culvert barriers. Existing culverts that impede passage should be replaced immediately. Examples of culverts that have been identified as barriers include Threemile Creek at U.S. Forest Service Road 110 crossing; Brownsworth Creek at U.S. Forest Service Road 34 crossing; culverts on Brownsworth Creek, 0.75 mile and 1.25 mile above U.S. Forest Service Road 34; the culvert 0.25 mile below U.S. Forest Service Road 34 (needs to be replaced to prevent repeated washout); the large diameter culvert at the Boulder Creek road crossing; nearly 80 percent of the culverts in the upper Sycan River watershed as identified in the Fremont National Forest inventory; and culverts in the North Fork Sprague River drainage, including North Fork Sprague River (2), Boulder Creek (1), Dead Cow Creek (1), and Sheepy Creek (1).

1.2.5 <u>Analyze watercourses for ability to pass bull trout</u>. Land use managers should assess all streams and manmade structures within their respective areas of responsibility to determine whether fish passage is blocked and/or fish are entrained. Creeks to be evaluated include Long, Deming, Threemile, Sun, Sevenmile, and Cherry Creeks.

1.2.6 <u>Provide fish passage at water diversions</u>. Appropriate fish passage structures should be installed at water diversions on bull trout streams, and barriers should be removed. Examples of areas that may require solutions to passage barriers include Cherry, Sevenmile, Sun, and Threemile Creeks.

1.2.7 <u>Eliminate entrainment in diversions</u>. Fish screens should be installed to prevent fish from entering diversion canals or pipes. Areas potentially needing screens include Long, Deming, Threemile, Sun, Sevenmile, and Cherry Creeks.

1.2.8 <u>Assess manmade barriers</u>. Evaluate manmade barriers as impediments to migratory bull trout and explore solutions if barriers are found to impede movement. Priority watersheds include Threemile, Sun, and Long Creeks.

1.3 Identify impaired stream channel and riparian areas and implement tasks to restore their appropriate functions.

1.3.1 Identify areas in and along streams for restoration. Streams should be surveyed to determine where reestablishment of canopy and shade would benefit native fish. Priority watersheds or stream reaches include Boulder and Threemile Creeks and the North and South Forks of the Sprague River.

1.3.2 Revegetate denuded riparian areas. Native riparian vegetation should be restored to reestablish canopy and shade in streams where investigation indicates actions are likely to benefit native fish. Priority watersheds or stream reaches include Boulder and Threemile Creeks and the North and South Forks of the Sprague River.

1.3.3 Improve grazing practices. Where investigation indicates actions are likely to benefit native fish, improve grazing practices. Priority watersheds or stream reaches include Paradise and Watson Creeks; the lower Sycan River above the marsh where sedimentation is a problem; and Brownsworth Creek and many streams in the North Fork Sprague and upper Sycan River drainages that are deficient in pool habitat.

Fine sediments should be reduced from the current 27 to 44 percent fines to less than 20 percent fines. Primary focus should be placed on managing livestock to develop riparian vegetation and managing beaver to increase the number and depth of pools. Sedge mats and root wads can be used to stabilize eroding banks.

1.3.4 Develop cooperative efforts with permittees and private landowners in the Upper Klamath Lake, Sycan River, and Upper Sprague River core areas to address riparian restoration and grazing issues. Recommendations by the Klamath Basin Bull Trout Working Group have resulted in land management agencies making changes to grazing practices in much of the basin's bull trout habitat. Additional efforts should be pursued to develop cooperative efforts with private landowners in the Upper Klamath Lake, Sycan River, and upper Sprague River drainages. Financial assistance and incentives may be available through the Klamath Basin Watershed Restoration Program or similar projects.

1.3.5 Improve instream habitat. Instream habitat should be improved by restoring historic stream channels, restoring recruitment of large woody debris, encouraging pool development, or carrying out other appropriate strategies in streams where investigation indicates that actions are likely to benefit native fish. Priority watersheds may include Brownsworth Creek, where spawning-size gravel is rare except behind large obstructions. Restoration of channel function in Penn Creek to reestablish an intermittent connection with Rock Creek would expand seasonal fish habitat and access to Penn Creek gravels; gravels are limited in Rock Creek. Managing beaver to increase the number and depth of pools would benefit native fish in Brownsworth Creek and many streams in the North Fork Sprague River and upper Sycan River drainages. Threemile, Brownsworth, Rock, Cherry, Paradise, and Watson Creeks and the lower Sycan River above the marsh would benefit from the reintroduction of large wood and through long-term management of streamside trees to provide adequate large wood in the future.

1.4 *Operate dams to minimize negative effects on bull trout in reservoirs and downstream.*

1.5 Identify upland conditions negatively affecting bull trout habitats and implement tasks to restore appropriate functions.

1.5.1 Assess watershed uplands for high runoff. Land managers should investigate each watershed 1) to identify upland areas that may be contributing to increased runoff in watersheds exhibiting low or intermittent stream flows, such as Rock, Cherry, Threemile, Boulder, and Hammond Creeks, and 2) to make recommendations for improvement.

1.5.2 Implement measures to increase water retention and slow runoff in watersheds exhibiting low or intermittent stream flows. In watersheds such as Rock, Cherry, Threemile, and Hammond Creeks, measures should be implemented to increase water retention and slow runoff from upland areas.

2 Prevent and reduce negative effects of nonnative fish and other nonnative taxa on bull trout.

2.1 Develop, implement, and enforce public and private fish stocking policies to reduce stocking of nonnative fish that affect bull trout.

2.2 Evaluate policies for preventing illegal transport and introduction of nonnative fish.

2.3 Provide information to the public about ecosystem concerns of illegal introductions of nonnative fish.

2.4 Evaluate biological, economic, and social effects of control of nonnative fish.

2.5 Develop tasks to reduce negative effects of nonnative taxa on bull trout.

2.5.1 Evaluate impacts of nonnative fish species in all bull trout-occupied waters and streams where reestablishment may occur. A multi-year brook trout removal program was initiated in 1996 in Threemile Creek. Monitoring to date indicates that this program has been successful. Monitoring and evaluation of brook trout impacts to bull trout should continue in Threemile Creek and should be expanded to include Crane Creek, Sun Creek, Wood River, and Long Creek. The impact of brown trout on bull trout should be evaluated in Boulder Creek, Brownsworth Creek, and the Sprague River. Evaluate potential for removal of brook trout in former bull trout streams where bull trout may be reestablished (*e.g.*, Cherry, Fourmile, Nannie, Rock, and Sevenmile Creeks).

2.5.2 Design measures to control nonnative fish. Based on results from task 2.5.1, programs to control the adverse impacts of nonnative fish species to bull trout should be designed (*i.e.*, capture, spearing, netting, piscicides, and others).

2.6 Implement control of nonnative fish where found to be feasible and appropriate.

2.6.1 Assess effectiveness of removing nonnative salmonids in bull trout streams. As part of efforts to control nonnative fish, land and resource management agencies, in conjunction with the Klamath Basin Bull Trout Working Group, should assess each stream in which nonnative salmonids have been removed to determine the effectiveness of the implemented measures.

3 Establish fisheries management goals and objectives compatible with bull trout recovery and implement practices to achieve goals.

3.1 Develop and implement State and Tribal native fish management plans integrating adaptive research.

3.1.1 Integrate bull trout recovery monitoring in the Klamath River basin into the Oregon Plan for Salmon and Watersheds. The Oregon Plan for Salmon and Watersheds (Oregon 1997) identifies a number of management actions that affect salmonids. Monitoring associated with bull trout recovery should be integrated into this program to insure coordinated action and to meet common goals and objectives.

3.1.2 Coordinate bull trout recovery with recovery efforts of other species. Resource managers should coordinate bull trout recovery efforts with management plans and strategies for other species (*e.g.*, shortnose and Lost River suckers and chinook salmon and steelhead) as necessary.

3.2 Evaluate and prevent overharvest and incidental angling mortality of bull trout.

3.2.1 Assess existing and potential impacts of angling on bull trout populations. Bull trout are highly susceptible to angling. Steps should be taken to minimize or eliminate incidental harvest of bull trout.

For example, because the Klamath Basin Bull Trout Working Group has successfully conducted an intensive program to remove nonnative fish in Threemile Creek, brook trout have nearly been eliminated from bull trout reaches. Therefore, there is little likelihood of an angler catching brook trout in this reach. Although angling pressure is light to nonexistent, any angling carries with it a significantly higher probability that incidental take of bull trout could occur. Given the low population size of bull trout in Threemile Creek, any incidental take associated with angling may have an adverse effect on the health and persistence of the bull trout population in this stream. Although the Oregon Department of Fish and Wildlife closed angling for bull trout in the Klamath River basin in 1991, closure to all angling in Threemile Creek was deemed the best method to address the threat of incidental take for that specific stream. At the request of the Klamath Basin Bull Trout Working Group, the Oregon Department of Fish and Wildlife closed Threemile Creek, above the Westside Road, to all angling in 2000.

3.2.2 Continue to implement and monitor compliance with protective angling regulations. Proposed changes to existing regulations must be scientifically supported relative to delisting criteria (*i.e.*, harvestable surplus), as demonstrated by the monitoring program.

3.2.3 Continue to provide information to anglers about bull trout identification and special regulations. Increase the number of identification posters along bull trout-inhabited streams in the Klamath River basin. Current poster photos depict migratory forms that are uncommon in the Klamath River basin. Because anglers are more likely to encounter the smaller, more common resident form, identification posters should be changed accordingly. Angler awareness can also be improved by identification and educational exhibits. Target key spawning/rearing and resident adult areas for additional angler education efforts.

3.3 Evaluate potential effects of introduced fish and associated sport fisheries on bull trout recovery and implement tasks to minimize negative effects on bull trout.

3.4 Evaluate effects of existing and proposed sport fishing regulations on bull trout.

4 Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.

4.1 Incorporate conservation of genetic and phenotypic attributes of bull trout into recovery and management plans.

4.1.1 <u>Determine genetic relationships among bull trout populations in the Klamath River Recovery Unit</u>. Samples have been collected from local bull trout populations in Threemile, Sun, and Long Creeks. Additional samples from other local populations need to be collected (*i.e.*, Brownsworth, Deming, Leonard, and Boulder/Dixon Creeks) and analyzed.

4.2 Maintain existing opportunities for gene flow among bull trout populations.

4.3 Develop genetic management plans and guidelines for appropriate use of transplantation and artificial propagation.

5 Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.

5.1 Design and implement a standardized monitoring program to assess the effectiveness of recovery efforts affecting bull trout and their habitats.

5.2 Conduct research evaluating relationships among bull trout distribution and abundance, bull trout habitat, and recovery tasks.

5.2.1 <u>Determine range of temperature tolerances for bull trout life stages in different habitats</u>. Use the results of ongoing temperature studies to address the adequacy of existing State of

Oregon and State of California regulations and recovery efforts.

5.2.2 Assess current and historical effects of upland management on changes to the hydrograph. Activities in upland areas, such as logging, road building, and grazing, have affected hydrograph regimes in bull trout watersheds. Effects include changes in the timing and magnitude of peak flows in Long Creek and Fourmile Creek watersheds. Flows in Hammond Creek have changed from perennial to intermittent.

5.3 Conduct evaluations of the adequacy and effectiveness of current and past best management practices in maintaining or achieving habitat conditions conducive to bull trout recovery.

5.4 Evaluate effects of diseases and parasites on bull trout and develop and implement strategies to minimize negative effects.

5.4.1 Research the effects of *Ceratomyxa shasta* on bull trout. Determine whether *C. shasta* is a limiting factor on the distribution of bull trout in the Klamath River basin.

5.4.2 Monitor presence of *Ceratomyxa shasta* in bull trout habitat. If *C. shasta* is a limiting factor in the distribution of bull trout in the Klamath River basin (task 5.4.1), monitor for presence in important bull trout spawning and rearing areas.

5.4.3 Assess fisheries and habitat management activities to reduce the risk of disease transmission. This measure includes maintaining and refining fish health screening and transplant protocols to reduce risk of disease transmission.

5.5 Develop and conduct research and monitoring studies to improve information concerning the distribution and status of bull trout.

5.6 Identify evaluations needed to improve understanding of relationships among genetic characteristics, phenotypic traits, and local populations of bull trout.

5.6.1 Delineate important migratory habitat. Investigate connectivity among core area populations in the Klamath River Recovery Unit, including seasonal use of different habitat types by adult and subadult migratory bull trout.

5.6.2 Assess severity of threat due to hybridization with brook trout. This measure includes determining the reproductive viability of bull trout/brook trout hybrids, brook trout colonization rates, desirability and effectiveness of barriers to brook trout passage, and evaluation of brook trout removal/eradication programs. Priority watersheds include occupied and potential habitat in the Upper Klamath Lake and Sycan River core areas identified in Table 6.

6 Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.

6.1 Use partnerships and collaborative processes to protect, maintain, and restore functioning core areas for bull trout.

6.1.1 Encourage floodplain protection. Development frequently exacerbates water temperature problems, increases nutrient loads, decreases bank stability, alters instream and riparian habitat, and changes hydrologic response of affected watersheds. To protect floodplains, land and resource agencies should promote land use planning and management that discourages development of floodplains and seeks long-term habitat protection through purchase, conservation easements, landowner incentives, and management plans. Local governments should be encouraged to develop, implement, and promote floodplain regulations that restrict encroachment and mitigate habitat loss throughout the upper Klamath River basin.

6.1.2 Promote collaborative efforts by supporting existing local watershed working groups in developing and accomplishing site-specific protection and restoration activities. Develop agreements with local watershed working groups to complete watershed assessment of private lands under Oregon Watershed Enhancement Board protocols. Integrate existing information from Federal watershed analysis with new information on private lands. Work with water management organizations to maximize instream flow through established water rights processes.

6.2 Use existing Federal authorities to conserve and restore bull trout.

6.3 Evaluate existing Federal, State, and Tribal habitat protection standards and regulations and evaluate their effectiveness for bull trout conservation.

7 Assess the implementation of bull trout recovery by recovery units and revise recovery unit plans based on evaluations.

7.1 Convene annual meetings of each recovery unit team to review progress on recovery plan implementation.

7.2 Assess effectiveness of recovery efforts.

7.3 Revise scope of recovery as suggested by new information.

IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows lists recovery task priorities; task numbers; task descriptions; duration of tasks; potential or participating responsible parties; total cost estimate and estimates for the next five years, if available; and comments. These tasks, when accomplished, will lead to recovery of bull trout in the coterminous United States as discussed in Part II of this recovery plan.

Parties with authority, responsibility, or expressed interest to implement a specific recovery task are identified in the Implementation Schedule. Listing a responsible party does not imply that prior approval has been given or require that party to participate or expend any funds. However, willing participants will benefit by demonstrating that their budget submission or funding request is for a recovery task identified in an approved recovery plan and is part of a coordinated recovery effort to recover bull trout. In addition, section 7 (a)(1) of the Endangered Species Act directs all Federal agencies to use their authorities to further the purposes of the Act by implementing programs for the conservation of threatened or endangered species.

The following are definitions to column headings and keys to abbreviations and acronyms used in the Implementation Schedule:

<u>Priority No.</u>: All priority 1 tasks are listed first, followed by priority 2 and priority 3 tasks.

Priority 1: All actions that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: All actions that must be taken to prevent a significant decline in species population or habitat quality or to prevent some other significant negative effect short of extinction.

Priority 3: All other actions necessary to provide for full recovery (or reclassification) of the species.

Task Number and Task Description: Recovery tasks as numbered in the recovery outline. Refer to the action narrative for task descriptions.

Task Duration: Expected number of years to complete the corresponding task. Study designs can incorporate more than one task, which when combined can reduce the time needed for task completion.

Responsible or Participating Party: The following organizations are those with responsibility or capability to fund, authorize, or carry out the corresponding recovery task.

Federal Agencies:

(BLM) Bureau of Land Management
(NPS) National Park Service
(USFS) U.S. Forest Service
(USFWS) U.S. Fish and Wildlife Service.

State Agencies:

(ODF) Oregon Department of Forestry
(ODFW) Oregon Department of Fish and Wildlife

Others:
(KBBTWG) Klamath Basin Bull Trout Working Group(includes the Klamath Tribes, National Park Service, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, U.S. Forest Service [Fremont and Winema National Forests], and U.S. Timberlands)
(KT) Klamath Tribes
(TNC) The Nature Conservancy

Bolded type indicates the agency or agencies that have the lead role for task implementation and coordination, though not necessarily sole responsibility.

Cost Estimates: Cost Estimates are rough approximations and provided only for general guidance. Total costs are estimated for both the duration of the task and also itemized annually for the next five years.

Implementation schedule for the bull trout recovery plan: Klamath River Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
1	1.1.1	Conduct watershed assessments	5	**LRMA**[1]	500	100	100	100	100	100	Ongoing[2]
1	1.1.2	Monitor sediment loading in current and potential bull trout habitat	25	**LRMA**	2,500	100	100	100	100	100	Ongoing
1	1.1.4	Modify roads and trails to allow natural drainage patterns	25	**LRMA**	1,250	50	50	50	50	50	Ongoing
1	1.1.5	Conduct limiting factors analysis for impact of roads	25	**LRMA**	2,500	100	100	100	100	100	Ongoing

[1] LRMA – All resource and land management agencies, private landholders, Tribal entities, and nongovernment organizations affected by or responsible for conservation of bull trout (*e.g.*, BLM, NPS, ODF, USFS, etc.).

[2] Ongoing Tasks are currently being implemented, typically at reduced funding levels and/or in only a small portion of the watershed.

Implementation schedule for the bull trout recovery plan: Klamath River Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
1	1.2.3	Monitor all road crossings	25	**LRMA**	100	10	10	10	10	10	Ongoing
1	1.2.4	Eliminate culvert barriers	10	**LRMA**	1,000	100	100	100	100	100	Ongoing
1	1.2.6	Provide fish passage at water diversions	10	**LRMA**	1,000	100	100	100	100	100	
1	1.2.7	Eliminate entrainment in diversions	10	**LRMA**	1,000	100	100	100	100	100	
1	1.3.1	Identify areas in and along streams for restoration	5	**LRMA**	50	10	10	10	10	10	
1	1.3.2	Revegetate denuded riparian areas	10	**LRMA**	1,000	100	100	100	100	100	Ongoing
1	1.3.3	Improve grazing practices	5	**LRMA**	500	100	100	100	100	100	Ongoing
1	1.3.5	Improve instream habitat	10	**LRMA**	1,000	100	100	100	100	100	

Implementation schedule for the bull trout recovery plan: Klamath River Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
1	2.5.1	Evaluate impacts of nonnative fish species in all bull trout-occupied waters and streams where reestablishment may occur	5	**KBBTWG** Research[3]	250	50	50	50	50	50	
1	2.5.2	Design measures to control nonnative fish	5	KBBTWG **LRMA**	50	10	10	10	10	10	
1	3.2.1	Assess existing and potential impacts of angling on bull trout populations	3	NPS **ODFW**	60	20	20	20			Every 4 years based on regulatory process

[3] Research – KBBTWG, ODFW, Universities, USFWS, U.S. Geological Service, Biological Research Division (BRD)

Implementation schedule for the bull trout recovery plan: Klamath River Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
1	3.2.2	Continue to implement and monitor compliance with protective angling regulations	25	NPS **ODFW**	1,250	50	50	50	50	50	Ongoing
1	5.6.2	Assess severity of threat due to hybridization with brook trout	5	**KBBTWG** Research	100	20	20	20	20	20	Ongoing
2	1.1.3	Reduce general sediment sources	10	**LRMA**	1,000	100	100	100	100	100	Ongoing
2	1.1.6	Monitor baseline instream habitat and watershed conditions	25	LRMA	2,500	100	100	100	100	100	Ongoing
2	1.1.7	Assess nutrient input from forestry and agriculture	10	LRMA	100	10	10	10	10	10	

Implementation schedule for the bull trout recovery plan: Klamath River Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
2	1.1.8	Implement measures to reduce nutrient input	5	LRMA	50	10	10	10	10	10	
2	1.1.9	Implement water quality regulations	5	LRMA	50	10	10	10	10	10	
2	1.1.10	Increase water quality monitoring	5	LRMA	50	10	10	10	10	10	
2	1.1.11	Increase enforcement of water quality standards	25	LRMA	100	10	10	10	10	10	Ongoing
2	1.2.1	Investigate methods to improve instream flows	10	**LRMA**	1,000	100	100	100	100	100	
2	1.2.2	Implement measures to improve instream flows	5	**LRMA**	500	100	100	100	100	100	Ongoing
2	1.2.5	Analyze watercourses for ability to pass bull trout	10	**LRMA**	1,000	100	100	100	100	100	
2	1.2.8	Assess manmade barriers	3	**LRMA**	30	10	10	10			

Implementation schedule for the bull trout recovery plan: Klamath River Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
2	1.3.4	Develop cooperative efforts with permittees and private landowners in the Upper Klamath Lake, Sycan River, and Upper Sprague River core areas to address riparian restoration and grazing issues	10	ODFW **USFWS**	1,000	100	100	100	100	100	Ongoing
2	1.5.1	Assess watershed uplands for high runoff	10	**LRMA**	100	10	10	10	10	10	
2	1.5.2	Implement measures to increase water retention and slow runoff in watersheds exhibiting low or intermittent stream flows	10	**LRMA**	200	20	20	20	20	20	

Implementation schedule for the bull trout recovery plan: Klamath River Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
2	2.6.1	Assess effectiveness of removing nonnative salmonids in bull trout streams	5	KBBTWG **LRMA**	100	20	20	20	20	20	
2	3.2.3	Continue to provide information to anglers about bull trout identification and special regulations	25	NPS **ODFW**	250	10	10	10	10	10	Ongoing
2	5.2.1	Determine range of temperature tolerances for bull trout life stages in different habitats	5	**KBBTWG** Research	100	20	20	20	20	20	
2	5.4.1	Research the effects of *Ceratomyxa shasta* on bull trout	5	ODFW Research **USFWS**	250	50	50	50	50	50	

Implementation schedule for the bull trout recovery plan: Klamath River Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
2	5.4.2	Monitor presence of *Ceratomyxa shasta* in bull trout habitat	25	KBBTWG	500	20	20	20	20	20	Ongoing
2	5.4.3	Assess fisheries and habitat management activities to reduce the risk of disease transmission	5	**ODFW** USFWS	50	10	10	10	10	10	
2	5.6.1	Delineate important migratory habitat	5	**KBBTWG** LRMA	50	10	10	10	10	10	
2	6.1.3	Promote collaborative efforts by supporting existing local watershed working groups in developing and accomplishing site-specific protection and restoration activities	5	KBBTWG LRMA **ODFW** USFWS	50	10	10	10	10	10	Ongoing

Implementation schedule for the bull trout recovery plan: Klamath River Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
3	3.1.1	Integrate bull trout recovery monitoring in the Klamath River basin into the Oregon Plan for Salmon and Watersheds	3	**ODFW**	30	10	10	10			
3	4.1.1	Determine genetic relationships among bull trout populations in the Klamath River Recovery Unit	5	LRMA **USFWS**	50	10	10	10	10	10	
3	5.2.2	Assess current and historical effects of upland management on changes to the hydrograph	5	**LRMA**	50	10	10	10	10	10	
3	6.1.1	Encourage floodplain protection	15	KBBTWG **LRMA** USFWS	3,000	200	200	200	200	200	

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APPENDIX A: Summary of Recovery in the Klamath Basin

1. The Klamath Basin Recovery Unit consists of 11 local populations (9 resident and 2 migratory) distributed in 3 core areas: the Upper Klamath Lake core area; the Sycan River core area; and the Upper Sprague River core area.
2. In the Upper Klamath Lake core area, 3 individual, nonconnected, local populations of resident fish reside upstream of impassable diversion structures located in headwater tributaries. No bull trout use the tributaries downstream of the structures.
3. The Sycan River core area has 2 local populations of bull trout, 1 with fish that migrate to an extensive marsh complex.
4. The Upper Sprague River core area has 4 local populations of resident bull trout and 1 remnant population of migratory fish. The source of the migratory fish is unknown.
5. Recovery is defined as: 1) stable self-sustaining local populations of bull trout: migratory forms (fluvial and/or adfluvial) in the Upper Klamath Lake core area and fluvial forms in the Sycan River and Upper Sprague River core areas; 2) consistent interchange of genetic material among appropriate core populations; 3) stable or upward trends in habitat quality and quantity in core areas and migration corridors through landscape-level adjustments in land management strategies designed to maintain and/or enhance structural and functional attributes of upslope, riparian, and fluvial systems; 4) an absence, or low incidence of, nonnative salmonids in core areas, in conjunction with a stable, native fish assemblage.

APPENDIX B. List of Chapters

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Chapter 2	**Klamath River Recovery Unit, Oregon**
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